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TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

DIGITAL VOLTMETER DANA MODEL 5600-S-638

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HEADQUARTERS, DEPARTMENT OF THE ARMY

JUNE 1972

This manual is an authentication of the manufacturer's commercial literature which, through usage, has been found to cover the data required to operate and maintain this equipment. Since the manual was not prepared in accordance with military specifications, the format has not been structured to consider level of maintenance nor to include a formal section on depot overhaul standards.

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HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 2 June 1972

OPERATOR'S ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL: DIGITAL VOLTMETER, DANA MODEL 5600-S-638

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SECTION 0
INTRODUCTION
0.1. SCOPE
0.2. This manual includes installation and operation instructions and covers organizational, direct support (DS), and general support (GS) maintenance. It described Digital Voltmeter, Dana Model 5600-S-638.
0.3. The basic issue items list appears in appendix C. Appendix C is current as of 23 March 1972.
0.4 INDEXES OF PUBLICATIONS
0.5 *DA Pam 310-4.* Refer to the latest issue of DA Pam 310-4 to determine if there are any new editions, changes, or additional publications pertaining to the equipment.
0.6 *DA Pam 310-7.* Refer to DA Pam 310-7 to determine whether there are Modification Work Orders (MWO's) pertaining to the equipment.
0.7 FORMS AND RECORDS
0.8 Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions given in TM 38-750.
0.9 *Report of Packaging and Handling Deficiencies.* Fill out and forward DD Form 6 as prescribed in AR 700-58 (Army), NAVSUP Pub 378 (Navy), AFR 71-4 (Air Force), and MCO P4030.29 (Marine Corps).
0.10 *Discrepancy in Shipment Report.* Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38 (Army), NAVSUP Pub 459 (Navy), AFM 75-34 (Air Force), and MCO P3610.19 (Marine Corps).
0.11 *Reporting of Errors.* The reporting of errors, omissions, and recommendations for improving this manual is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications), and forward direct to Commanding General, U.S. Army Missile Command, ATTN: AMSMI-MFM, Redstone Arsenal, AL 35809.

Section 1

General Description

1.1 INTRODUCTION

The Dana Model 5600 Digital Voltmeter is a high precision, five-digit instrument suitable for both laboratory and system applications. When fully equipped, the Model 5600 measures AC and DC volts, ohms, millivolts, and ratios. An electrical output accessory provides binary-coded decimal readings to a printer — or other output device — in the form of contact closures at the output connector.

Since all accessories fit within a guarded measurement compartment, this instrument's high common mode voltage rejection (120 dB) is maintained under all measurement conditions — even when connected to a grounded output device.

The instrument's extremely high input impedance (10,000 megohms on the 10-volt range) allows it to be used with high impedance sources with negligible loading error. A megohm source, for example, creates less than 0.01% loading error. The high input impedance is constant, whether the instrument is on or off null. "Kickback" current during the off null phase of the measurement cycle is insignificant.

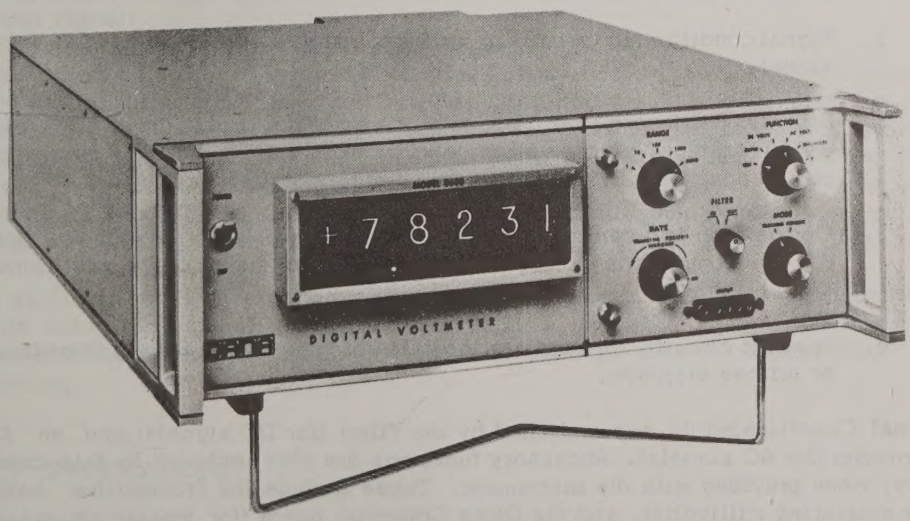


Figure 1.1 - Dana Model 5600 Digital Voltmeter

All instrument functions are controlled by five simple front panel switches located directly alongside the instrument's digital display. The operator has a choice of manual or automatic range selection. The automatic ranging feature applies to all types of measurements, including millivolts. Two reading techniques are provided: Periodic, with new readings commanded at time intervals that may be varied from 1/5 to 1 second, and Tracking, with a new reading commanded automatically each time the signal departs from the previous reading by one digit.

1.2 OPERATIONAL DESCRIPTION

All circuits are contained on plug-in circuit boards. There are 26 circuit board locations in the unit. Each of these locations is designated, beginning at the operator's left, as Number 1, and proceeding to the last board in position number 26, on the extreme right. The basic voltmeter circuitry occupies the majority of these locations. The remaining locations are used to accommodate accessories, including the Filter, Preamplifier, Ohms Converter, and the two AC Converters.

The Dana Model 5600 Digital Voltmeter makes use of the classic potentiometric method of determining the ratio between two voltages. A known fraction of one voltage (designated as the "reference" voltage) is brought to an exact null balance with the unknown "signal" voltage. The readout, visual or printed, is a digital representation of the ratio between the two. The fraction of the reference voltage that produces a null balance with the signal voltage is designated as the "comparison" voltage. Four basic circuit elements are required in such an instrument.

1. Signal conditioning circuits to produce a stable, noise-free, DC input signal.

2. Signal conditioning circuits to produce a stable, noise-free, DC reference voltage, plus a voltage divider that can be digitally controlled to any one of 99,999 positions in 20 binary steps.

3. Comparison and control circuits to adjust the voltage divider to produce a comparison voltage that is the exact match of the conditioned signal voltage.

4. Readout circuits to translate the state of the voltage divider into visual or printed displays.

Signal Conditioning is accomplished by the Filter (for DC signals) and an AC Converter (for AC signals). Accessory functions are also included in this category, when provided with the instrument. These include the Preamplifier board (for measuring millivolts), and the Ohms Converter board (for measuring resistances). In each case, the accessory board (including the AC Converter) provides a stable DC signal to the comparison circuitry.

The Reference Voltage is generated by either the Internal Reference board or an external source. The output of the Internal Reference board is an exact 11.0000 volts, which is then attenuated by voltage dividers on the five Decade boards to produce an absolute measurement of the signal in terms of volts, millivolts, ohms, etc.

A DC external reference voltage is passed through the buffer circuitry on this same board, then attenuated by the Decade boards to establish the ratio between the signal and external reference voltages.

The comparison and control circuits are contained on the Null Detector, Auto Range and Program boards. The function of the Null Detector is to determine whether the comparison voltage from the Decade boards is larger or smaller or exactly the same (within one part in 99,999) as the conditioned input signal. It produces an UP trigger, a DOWN trigger, or no trigger at all. The Program board uses this information to step the Decade boards through a logic sequence known as "successive approximation." At the end of this fixed sequence, the transistor switches on the Decade boards are set in a digital array that exactly represents the value of the comparison voltage, which in turn equals the conditioned input signal. The Auto Range board sets the digital voltmeter range as required to properly measure the input signal.

The Program board also uses the UP and DOWN triggers to control the Range board and assure that the conditioned input signal is always at 10 volts full scale (unless, of course, the range has been fixed by the manual front panel range control). A third function of the Program board is to switch the polarity of the comparison voltage so that it is always of the same sense as the conditioned input signal.

The output circuits are contained on three Readout boards. Two of these translate the digital information from four Decade boards into visual Nixie numerals representing the 1, 10, 100 and 1,000 decades. The third Readout board produces the 10,000 decade numeral, plus a decimal point indication (based on information from the Range board) and a polarity sign (based on the polarity of the comparison voltage). The polarity sign is replaced by a function symbol when the signal AC Converter or Ohms Converter is in operation.

If an Electrical Readout accessory is included in the instrument, the information from the Readout boards is also sent directly or through a binary code matrix to the Electrical Readout module, where it is used to code the digital recording device.

1.3 SPECIFICATIONS

See page 1-4.

DC Volts	
Full scale ranges	±9.9999, ±99.999, ±999.99 v, ranging and polarity automatic
Accuracy	
Short term	±0.005% of reading or ±0.001% of f.s. (under A.S.A. reference conditions)
Long term (6 months) +12° to +40°C	±0.01% of reading or ±0.001% of f.s.
Response time	
Digitizing	22 milliseconds
Digitizing with polarity change	63 milliseconds
Digitizing—worst case, range & polarity change	147 milliseconds
Full scale step function settling time	10 milliseconds
Input resistance—at or off null:	
10 v range	10,000 megohms (loading error <0.01% with 1 megohm source)
100 and 1000 v range	10 megohms
Common mode rejection, dc to 60 cps	130 db, filtered, with up to 1000 ohms in either lead; 120 db, unfiltered, with up to 100 ohms in either lead
Normal mode rejection	from 37 db to 80 db, at 59 cps and above, with choice of speeds from 0.2 second to 2 seconds (see filter specifications below)
Warm-up	½ hour to full accuracy
Size	5¼" rack height
Power requirement	45 watts, 105 to 125 v, 50 to 70 cps
Guarantees	12 months, faulty workmanship or component failure; 18 months, ability of reference voltage to hold within stability specification for any previous consecutive six months

DC Ratios	
Full scale ranges	.99999:1, 9.9999:1, 99.999:1, ranging automatic
Accuracy	9.9999 range: ±0.002% other ranges: ±0.01% of reading ±0.001% $\left(\frac{10\text{ v}}{\text{ref input}}\right)$ of f.s. (multiply by 2 when ref input <2 v)
External reference input resistance	20 megohms minimum
Maximum reference input	+11v (−11 v or ±100 v available on special order)
Ratio polarity combinations	+/+ standard (on special order, select −/− or +/− or −/+ instead)

WITH MODELS 20 & 25 AC CONVERTERS	
Maximum voltage rating	500 v rms, 50 cps to 10 kc, decreasing to 150 v at 50 kc and above
Full scale ranges	.99999, 9.9999, 99.999, 999.99 v rms, ranging automatic
Accuracy (3 months)	
Model 20 (20 kc)	±0.1% of reading or ±0.02% of f.s., 50 cps to 10 kc; ±0.25% of reading or ±0.03% of f.s., 10 kc to 20 kc
Model 25 (100 kc)	±0.1% of reading or ±0.02% of f.s., 50 cps to 10 kc; ±0.25% of reading or ±0.05% of f.s., 10 kc to 50 kc; ±0.5% of reading or ± 0.1% of f.s., 50 kc to 100 kc
Response time	
Step response	0.4 second to within 0.1% of final value
Response time with range change	1.5 seconds
Common mode rejection, dc to 60 cps	120 db with up to 100 ohms in either lead
Input resistance	1 megohm in series with 0.22 microfarad, all ranges
Shunt capacitance (exclusive of external cable)	less than 47 pf, all ranges

WITH MODEL 11 PREAMPLIFIER	
Full scale ranges	±9.9999, ±99.999, ±999.99 millivolts, ranging and polarity automatic
Accuracy (6 months)	±0.02% of reading or ±0.01% of f.s.
Zero stability	±5 microvolts
Response time (to 0.01%)	
Step response	1 second
Response with range change	3 seconds
Input resistance	100 megohms minimum
Common mode rejection, dc to 60 cps	at least 130 db with up to 1000 ohms in either lead

WITH MODEL 02 OHMS CONVERTER	
Full scale ranges	.99999, 9.9999, 99.999, 999.99 kilohms, ranging automatic
Accuracy (6 months)	±0.01% of reading and ±0.001% of f.s. except 1000 kilohm range; ±0.03% of reading and ±0.001% of f.s. on 1000 kilohm range
Response time	
Step response	100 milliseconds
Response with range change	200 milliseconds
Voltage across unknown	10 volts at f.s. maximum current limited to 10 ma on 1 k range

WITH MODELS 50, 55 & 58 INPUT FILTERS	Model 50	Model 55	Model 58 fast position	normal position
AC rejection (no "comeback" frequencies)				
59 cps and above	37 db min	37 db min	37 db min	80 db min
300 cps and above	51 db min	80 db min	80 db min	100 db min
Settling time to within 0.01% with up to 100 k source resistance	2 sec	200 msec	200 msec	950 msec
Maximum source resistance	1 megohm	1 megohm	1 megohm	1 megohm
Filter characteristics	one-pole	three-pole Gaussian	three-pole Gaussian	three-pole Gaussian
Cutoff rate	6 db/octave	18 db/octave	18 db/octave	18 db/octave
AC input impedance (exclusive of external cable)				
10 v range (shunted by 47 pf)	900 k ohms min	900 k ohms min	900 k ohms min	900 k ohms min
100 and 1000 v ranges (shunted by 47 pf)	9 megohms min	9 megohms min	9 megohms min	9 megohms min

Section 2

Installation And Initial Checkout

2.1 UNPACKING

The Model 5600 instrument is shipped in a completely assembled state, ready for immediate use. Carefully remove the instrument from its shipping carton. Inspect for dents, scratches, or other obvious evidence of physical damage. This should be done while the carrier's agent is still present.

Each instrument is shipped with input cables, mating connectors and other loose parts. These are contained in a closed compartment within the shipping carton. Care should be taken so that they are not lost in the unpacking process. A list of this material follows:

Part No.	Description
600127	Power Line Cable
400396	Signal Input Cable Assembly
400397	Reference Input Cable Assembly
400328	Calibration Cable
450362	Rack Mounting Flanges and Screws

2.2 INSPECTION

Examine the Nixie and neon indicator bulbs. Check all of the switches. Rotary controls on the front panel should turn freely.

Unscrew the knurled knob on the right-hand door and open the door. Both doors should swing easily on their hinges. Check the printed circuit cables connecting the Nixie bulb sockets with their mating circuit boards. There should be no kinks or scratches on these cables. Be sure they are securely seated in their connectors.

Check each circuit board to be sure it is fitted snugly in its connector. The boards are designed to fit the rear connectors tightly and must be pushed firmly in place with strong pressure for the last 1/8" of travel.

Any faults uncovered by this physical inspection should immediately be reported. See Section 0, Paragraph 0.9.

2.3 INSTALLATION

If the unit is to be used as a bench-top instrument, it is shipped ready for use. If the unit is to be rack-mounted, the mounting brackets (shipped with the instrument) must be installed. The mounting holes are beneath the decorative aluminum tape on the sides. Screws are provided to install the brackets. If necessary, the four plastic feet and kickstand can be removed. Once the power line and input and/or output cables have been attached, all future servicing and checkout of the instrument may be made through the front of the unit without removing it from its rack (except for power supply assembly).

The power line supplied with the instrument is a standard three-conductor cable terminating with a standard three-connector wall plug. At the instrument, the power line plugs into a three-pin connector. Signal connections to the Model 5600 consist of test cables used for taking measurements. These connections are described under paragraph 3.2, "Operating Procedures."

Figure 2.1 lists the digital voltmeter external connectors and identifies the mating connector for each. Signal and reference input cables are supplied with the instrument.

Connector	Name	Mating Connector
J101	Input (front)	Cannon DBM-5W5P*
J202	Electrical Output	Amphenol 57-30500
J203	Reference Input	Cannon DBM-5W5P*
J204	Command Input	Amphenol 126-217
J205	Input (rear)	Cannon DBM-5W5P*
		*Also requires:
		DM53740-5001 coaxial plug and DB51212-1 junction shell

Figure 2.1 - Mating Connector Identification

2.4 ELECTRICAL OUTPUT

The Model 48 Electrical Output Accessory provides output voltage levels at the electrical output connector at the rear of the unit. Pin assignments of the connector are identified in the appropriate drawing in Section 6. The BCD output code is defined in Figure 2.2. Output option 48-638-H1 is compatible with a HP562 Printer having a 1-2-2-4 "positive true" option.

	48-638-H1 Output Option			
	1(X1)	2(X2)	2(X3)	4(X4)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	1	0
5	1	1	1	0
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1
Range 1	1	1	1	0
Range 10	0	1	1	0
Range 100	1	1	0	0
Range 1000	0	1	0	0
+ Polarity	0	0	0	1
- Polarity	1	0	0	1
Function - Ohm	0	0	1	1
Function - AC	1	0	1	1

"1" indicates a positive voltage.
"0" indicates 0 voltage.

Output Data Format (printed)

XXXXX (S/F) R

where

XXXXX = digital value (printed as whole number).
S/F = sign and function (- for minus, blank for +, 6 for ohms, 7 for AC).
R = range (number of places decimal point moved to left).

Example:

5251873 = 52.518 V_{ac}

A "ready-to-print" signal is available at pin 48 of J202; signal goes from "0" to "1" at end of conversion, remains at "1" until a new conversion starts.

Figure 2.2 - Standard "H" Output Options

2.5 CHECKOUT PROCEDURE

The purpose of the checkout procedure is to verify that the instrument is in an operational condition. The simple tests described in this section are meant only to evaluate the gross characteristics of the instrument. They should not be confused with the more refined recalibration procedure described in Section 5.

Each instrument is completely checked out before it leaves the factory — including temperature and vibration tests plus a 100-hour run-in. Consequently, if it should fail any of these trials, it indicates that damage has occurred during shipment. No attempt at field servicing should be made. Instead, both the carrier and the Dana representative should be notified immediately.

The test equipment needed for the checkout procedure is a set of batteries (or DC power supplies) capable of producing voltages in each of the instrument's ranges plus a three-terminal potentiometer or resistance box capable of dividing these voltages.

Prior to performing the initial checkout procedure, it may be advisable to refer to the descriptions of the operating controls at the beginning of Section 3.

2.5.1 Power On

Turn the Mode switch to the Periodic position. Switch the Signal Range control to Automatic. Turn the Function control to the Test position. Turn Tracking/Periodic rate control fully counterclockwise. Turn the Print Output switch (located on the left side of the DVM board box) to OFF.

Insert the power line plug into a wall receptacle or other source of 115 volt AC power and connect to the instrument. Turn the Power switch on the left-hand front panel door to the ON position. A number should appear on the Nixie display. This number should correspond, within ± 6 digits, to the value of the most recent entry to Test A on the Calibration log attached to the inside of the front panel door.

2.5.2 Zero Point

Plug in the Signal Input Cable Connector at the front of the instrument. Turn the Function Control to read volts. Short the two input leads. The visual display should read 0.0000 after a 1/2 hour warm-up. Several times a year it may be required to reset the voltmeter to zero by using the screwdriver adjustment on the front of the null detector (green-yellow, slots 16 - 17). Merely short the leads and adjust to read all zeros. This is an operational control and does not require recalibration facilities. With the leads still shorted, turn the Range Control to the 1000-volt range. The visual display should read 000.00. Turn the Range Control to the remaining ranges, noting the position of the decimal point in each case. The polarity symbol may be either plus or minus.

2.5.3 Polarity Tests

To test the ability of the instrument to detect and display polarity, connect the leads to the batteries to obtain either a plus or minus polarity, then reverse the leads. The same number (± 1 digit) should be reproduced, but with an opposite

sign. Repeat the test for each range, using battery combinations that are between 10% and 100% of the full scale of the range being tested.

2.5.4 Range Changes

Switch the Range Control to Automatic. Connect the leads to the various battery combinations used above. Notice whether the instrument automatically adjusts to the optimum range. Next, connect the leads to the battery combination used for testing the 0-10 volt range, and note the reading. Move the Range Control to the 100 and 1000 volt positions. The number should move progressively to the right with each range change. Repeat the experiment with the battery combinations used for the 100 and 1000 volt ranges.

Note

The 1.0 volt range position on Model 5600 instruments is not operative in the DC volt and millivolt functions, but is used for measuring resistance and AC volts.

2.5.5 Range Transfer Points

Connect a variable resistor or potentiometer into the battery circuit. The objective is to attenuate the test voltage past the automatic range transfer points. (Up-ranging occurs at 99.999% of full-scale; down-ranging occurs at 9.909% of full-scale.) Turn the Range Control to the Automatic position. Using the most appropriate battery combinations for each transfer point, slowly adjust the input signal to test both the up-range and down-range transfers.

2.5.6 Tracking Mode

Turn the Mode control to Tracking. With the Rate control fully counterclockwise, use one of the battery combinations to test the stability of the reading. New readings should occur only when the voltage is changed. If readings are being triggered due to noise, turn the Rate control clockwise until the readings become stable. Slowly vary the voltage, allowing the instrument to track its progress.

2.5.7 Periodic Mode

Turn the Mode switch to "Periodic." Turn the Rate control fully counterclockwise. The meter should recycle or "periodic" about five times a second. Slowly increase the display time (turn clockwise). The periodic rate should slow to about once a second as you near the stop. Turning the control to Hold will restrict the instrument from taking any new readings. Release from Hold commands an immediate new reading.

2.5.8 Common Mode Rejection

To test the Common Mode Rejection, connect the instrument as shown in Figure 2.5. The signal should be a battery of less than 10 volts and the common mode source a signal generator (usually with step-up transformer) set for 100 volts peak at 60 cps. Switching the common mode voltage in and out should not affect the reading by more than ±1 digit. If necessary, adjust E_S slightly to ensure that the value of E_S does not disagree with the reading by a fraction of a digit.

2.5.9 Ratio Operation

Place the Function Switch in the Ratio position. Connect external reference supply (0 to 11 volts with full resolution above 10 volts) between the digital voltmeter "Ext Ref" and "Volts Common" terminals, and a second voltage between "Volts Input" and "Volts Common" (both inputs positive with respect to Common). The digital voltmeter should display a reading equal to the ratio of Signal Voltage/ Reference Voltage. If the instrument fails to function, check the fuse on the reference buffer board (position 18).

In applications where it is not feasible to connect both signals to a common point, a differential amplifier such as the Dana Model 3400 must be used (converting the four-wire input to the three-wire system of the digital voltmeter).

2.6 TEST SETTINGS

There are two internal self-check tests available designated as Test "A" and Test "B".

2.6.1 Test "A"

The Test position on the Function control is a self-check on the digital portions of the instrument. In effect, the instrument measures the output of its Internal Reference before it has been amplified by the Buffer Amplifier to an exact 11.000 volts. The precise value will vary for each instrument, but should be

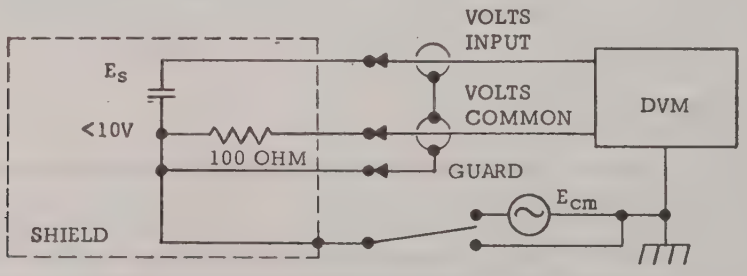


Figure 2.5 - Common Mode Rejection Test

stable within ±6 digits of the factory-determined voltage written on the calibration log for this reading. If there is a gross change in the Test A reading, it indicates a major malfunction in the instrument which requires immediate repair. If there is a slight variation of more than 6 digits, it indicates that the instrument is probably off calibration. However, a stable Test A reading does not necessarily mean that the instrument is in calibration. This can be determined only by the procedure outlined in Section 5. Test A is used as a quick check on the basic operability of the instrument, not its accuracy.

2.6.2 Test "B"

Test B, on the other hand, is used to monitor the long term stability of the Internal Reference, as part of the recalibration procedure. The Test "B" measurement is obtained by retaining the Function Switch in the Test position, opening the right-hand door and pushing the small button at the front of the Reference Buffer board (position 18). The Test B voltage is, in effect, a sensitive measure of the setting of the calibration vernier in the Internal Reference circuit and its recorded value is an absolute method of recapturing the setting used at the last calibration. Again, a Test B reading that remains stable does not necessarily indicate that the instrument is in calibration. Stability is determined by the difference in successive Test B readings, as recorded after each calibration.

Section 3

Operation

3.1 CONTROLS (Figure 3.1)

3.1.1 SIGNAL RANGE Switch

The RANGE switch has five positions:

1, 10, 100, and 1000. These positions allow selection of one of the four values as full-scale range for the function being measured.

AUTO. In the AUTO position, internal circuits select the proper range automatically.

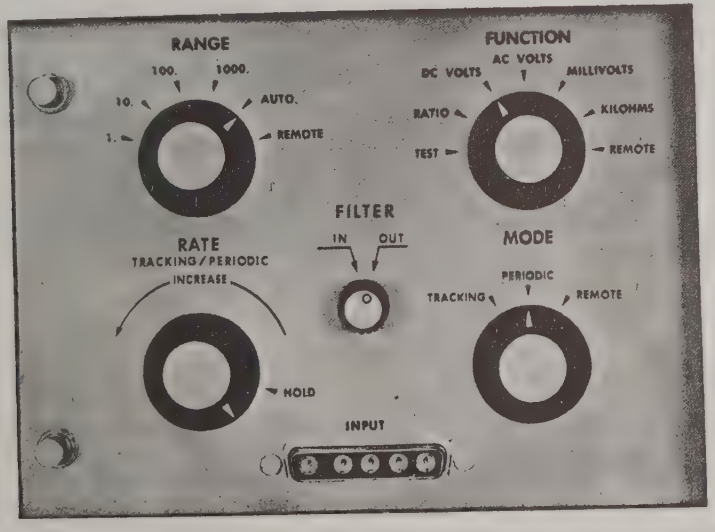


Figure 3.1 - Model 5600 Operating Controls

3.1.2 FUNCTION Switch

The FUNCTION switch selects the function to be measured or a test position.

TEST. This position selects a self-test of the digital portion of the instrument. Two tests can be performed: Test A and Test B. These tests are described under paragraph 2.6, "Test Settings."

RATIO. In this position, the meter displays the ratio of the signal voltage, at the "volts input" terminals, to the reference voltage applied to the "reference input" terminals.

DC VOLTS. This position selects the measurement of DC volts applied to the "volts input" terminals.

AC VOLTS. This position selects the measurement of AC volts; it functions only when the AC/DC converter accessory is installed in the unit.

MILLIVOLTS. This position selects the measurement of DC voltage in millivolts; it functions only when the Preamplifier accessory is installed in the unit.

KILOHMS. This position selects a resistance measurement; it functions only when the Ohms/DC converter accessory is installed in the unit.

3.1.3 MODE Switch

The basic mode of operation of the DVM is selected by setting the MODE switch to the desired position.

PERIODIC. This position selects the periodic mode of operation in which new data readings are taken at specific intervals determined by the setting of the RATE control.

TRACKING. This position selects the tracking mode of operation in which a new reading occurs only when the input voltage changes by more than one digit.

3.1.4 RATE Control

This control is a potentiometer which determines the interval at which data readings are taken when operating in the periodic mode. The interval between readings increases from approximately 1/5 to 1 second as the control is rotated counterclockwise. At the extreme clockwise rotation, the HOLD position is activated (a switch position). In this position, the instrument is prevented from taking a new reading. Removal of the control from the HOLD position commands a new reading immediately.

3.1.5 FILTER Switch

The FILTER switch has two positions: IN and OUT. When placed on IN, an input filter is connected to the instrument (see 4.2.1). The OUT position removes the filter.

3.2 OPERATING PROCEDURES

Generally, operation consists of selecting the appropriate control settings for the function being measured. In addition, each type of measurement requires a particular arrangement of input cable connection.

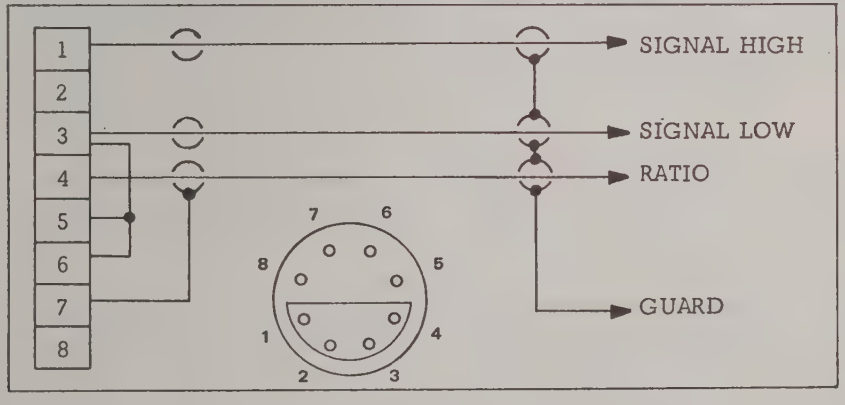
3.2.1 Signal Input Cable

The input cable plugs into the input connector on the front panel of the instrument. The cable consists of four leads color-coded as follows:

Signal High Lead	-	Red (banana plug)
Signal Low Lead	-	Black (banana plug)
Ratio Lead	-	White (banana plug)
Guard	-	Black (alligator clip)

3.2.2 Pin Assignments

The input connector is an AMP P3-8M13. Pin assignments are shown in the following diagram:



Following are general directions for the use of each signal lead:

Signal High - Red

This lead should always be connected to the side of the signal voltage farthese from ground potential regardless of signal polarity.

Signal Low - Black

Connect to the side of the signal voltage (and reference voltage, in the case of ratio measurements) closest to ground potential.

Guard - Black

Normally this should be fastened to Volts Common, but for the best isolation it should be connected directly to the source of any interference signal which may be present. Voltage between guard clip and common should be limited to 200 VDC.

Ratio - White

This lead is connected to the external reference supply when making voltage ratio measurements. Although the reference input circuit is fused (fuse is located on the front of the internal reference and buffer board — blue-yellow address 18), care should be taken to avoid exceeding the 11-volt rating.

Section 4

Theory Of Operation

4.1 INTRODUCTION

The descriptions and simplified diagrams throughout this section are intended to supplement the complete schematic drawings included in Section 6. The logic symbols used in the drawings are defined in Figure 4.1.

A diagram of Model 5600 operation is shown in Figure 4.2. All operations are controlled and timed by a 1 kc clock located on the Program board. After proper setting of controls, selection of reference voltage, etc., the measurement cycle starts when the READ flip-flop on the Program board is set. It is assumed that until that time it has been in a $\overline{\text{READ}}$ (not read) condition because (1) in the tracking mode the conditioned input signal has not departed from the comparison voltage by more than one digit, (2) in the periodic mode the time delay circuit that controls the periodic rate has not run through its cycle, or (3) an externally generated COMMAND has not been received.

In any case, when the read signal is received, all five of the Decade boards are set to 9. The comparison voltage at this time is therefore 9.9999 volts, either positive or negative, depending on the polarity of the previous reading.

The Decades then step through a sequence of 20 successive approximation trials, starting with the most significant binary-coded decimal bit on the highest decade. Each Decade has four such bits, representing 2*, 4, 2, and 1 for that decade. Starting with the most significant bit, each bit is dropped in succession. If an UP trigger signal is produced by the Null Detector, signifying that the comparison voltage is now less than the conditioned input signal, the bit is replaced. If no UP trigger is received, the bit is not replaced. At the end of 20 trials, four for each decade, the bits that remain in place provide a binary-coded decimal representation of the comparison voltage that comes closest to matching the conditioned input signal.

There is then a delay of one clock cycle, or one millisecond, before the reading is displayed. During the first one-half cycle, a check is made to verify that polarity is correct. If the polarity is not correct, the Decades will be signifying a reading of 00000 and the final comparison will have produced a DOWN trigger. In such a case, circuits on the Program board immediately initiate a polarity change and, after an appropriate delay, the Decades are reset to produce a comparison voltage of 9.9999 volts. The successive approximation sequence then begins over again.

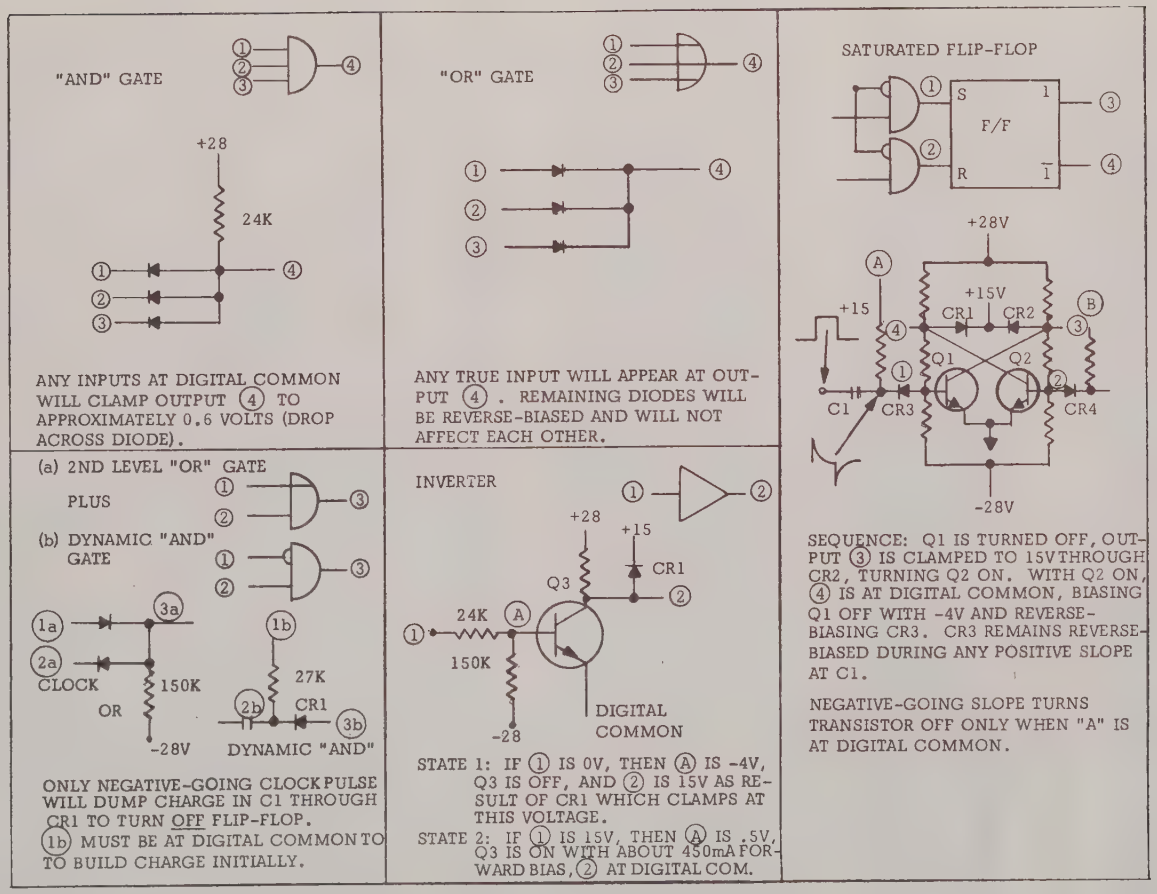
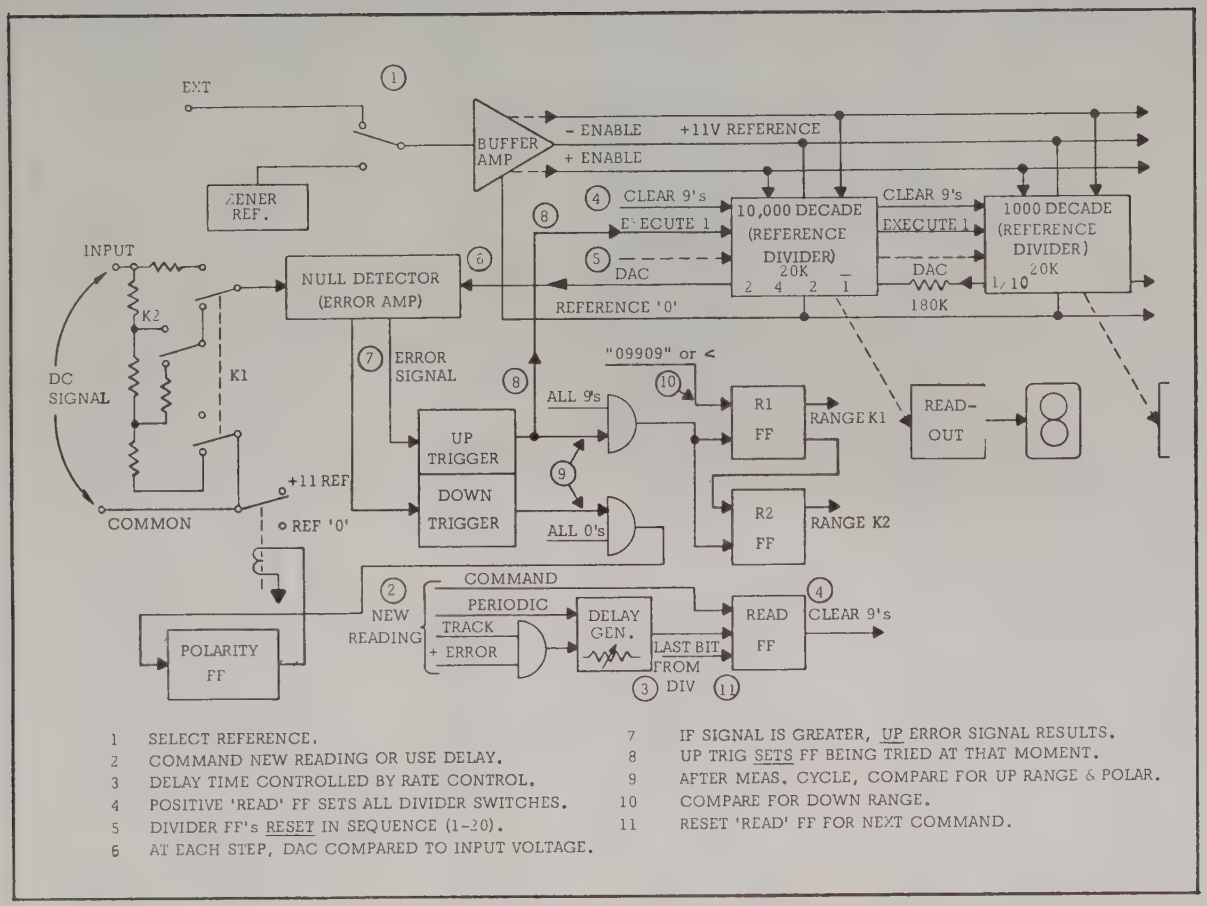

"AND" GATE
+28
24K
ANY INPUTS AT DIGITAL COMMON WILL CLAMP OUTPUT (4) TO APPROXIMATELY 0.6 VOLTS (DROP ACROSS DIODE).
"OR" GATE
ANY TRUE INPUT WILL APPEAR AT OUTPUT (4). REMAINING DIODES WILL BE REVERSE-BIASED AND WILL NOT AFFECT EACH OTHER.
SATURATED FLIP-FLOP
S
R
F/F
+28V
+15V
+15
CR1
CR2
Q1
Q2
C1
CR3
CR4
-28V
SEQUENCE: Q1 IS TURNED OFF, OUTPUT (3) IS CLAMPED TO 15V THROUGH CR2, TURNING Q2 ON. WITH Q2 ON, (4) IS AT DIGITAL COMMON, BIASING Q1 OFF WITH -4V AND REVERSE-BIASING CR3. CR3 REMAINS REVERSE-BIASED DURING ANY POSITIVE SLOPE AT C1.
NEGATIVE-GOING SLOPE TURNS TRANSISTOR OFF ONLY WHEN "A" IS AT DIGITAL COMMON.
(a) 2ND LEVEL "OR" GATE
PLUS
(b) DYNAMIC "AND" GATE
CLOCK
OR
150K
27K
-28V
DYNAMIC "AND"
ONLY NEGATIVE-GOING CLOCK PULSE WILL DUMP CHARGE IN C1 THROUGH CR1 TO TURN OFF FLIP-FLOP.
(1b) MUST BE AT DIGITAL COMMON TO TO BUILD CHARGE INITIALLY.
INVERTER
+28
+15
CR1
Q3
24K
150K
DIGITAL COMMON
-28
STATE 1: IF (1) IS 0V, THEN (A) IS -4V, Q3 IS OFF, AND (2) IS 15V AS RESULT OF CR1 WHICH CLAMPS AT THIS VOLTAGE.
STATE 2: IF (1) IS 15V, THEN (A) IS .5V, Q3 IS ON WITH ABOUT 450mA FORWARD BIAS, (2) AT DIGITAL COM.

Figure 4.1 - Data Logic Symbols



1 SELECT REFERENCE.
2 COMMAND NEW READING OR USE DELAY.
3 DELAY TIME CONTROLLED BY RATE CONTROL.
4 POSITIVE 'READ' FF SETS ALL DIVIDER SWITCHES.
5 DIVIDER FF's RESET IN SEQUENCE (1-20).
6 AT EACH STEP, DAC COMPARED TO INPUT VOLTAGE.
7 IF SIGNAL IS GREATER, UP ERROR SIGNAL RESULTS.
8 UP TRIG SETS FF BEING TRIED AT THAT MOMENT.
9 AFTER MEAS. CYCLE, COMPARE FOR UP RANGE & POLAR.
10 COMPARE FOR DOWN RANGE.
11 RESET 'READ' FF FOR NEXT COMMAND.

Figure 4.2 - Model 5600 Program Sequence

The second half clock cycle delay at the completion of the measurement is used to determine whether the instrument is on the proper range (assuming that the instrument is set to autorange). The comparison voltage is evaluated. If it is less than 0.9909 volts and the instrument is not already on the lowest range, a timeout is taken while the instrument drops to the next lowest range and the measurement repeated. On the other hand, if the comparison voltage is 9.9999 volts and the Null Detector has produced an UP trigger, the instrument automatically switches to the highest (1,000 volt) range. Measurement and range changes are repeated as necessary to produce a final output that is neither 9.9999-up (except on highest range) nor less than 0.9909 volts (except on lowest range). The total reading time of a DC voltage, with a polarity change and a maximum number of range changes, is never more than 147 milliseconds (see Figure 4.3). During this time, the polarity indication on the visual readout is replaced by an "R" to indicate that the instrument is ranging and the display is not correct.

4.2 SIGNAL CONDITIONING

Signal conditioning is performed by the optional accessory boards provided with the instrument. The accessory boards include the Input Filter, AC Converter, Preamplifier, and Ohms Converter. The purpose of these circuits is to provide a stable noise-free DC voltage from the AC, DC, low-level DC, or resistance inputs. This stable reference voltage is applied to the Null Detector where it is brought to null with a known voltage during the "successive approximation" sequence.

The signal conditioning circuits are described in the following paragraphs. Complete schematics and calibration procedures are included in the Dana Accessories Manual.

4.2.1 Input Filter

Three models of input filter are available: two are active and one a passive filter. Models 55 and 58 are similar active filters. Functionally, the two models are connected as damped three-pole capacitive multipliers (see Figure 4.4). The circuit is combined with the output resistance of the input divider to form an active RC filter network. The amplifier gain increases the effective value of C proportional to the cube of the input frequency. In the Model 55 filter, the amplifier feedback network is fixed; in Model 58, the gain of the amplifier is switched by changing the feedback network that establishes amplifier gain. This is done by an Attenuator switch on the board itself. AC rejection of the two filters is listed on page 4.6.

Model 50 is a one section passive RC filter. This model provides 37dB minimum rejection at 60 Hz and above and 51dB minimum at 300 Hz and above.

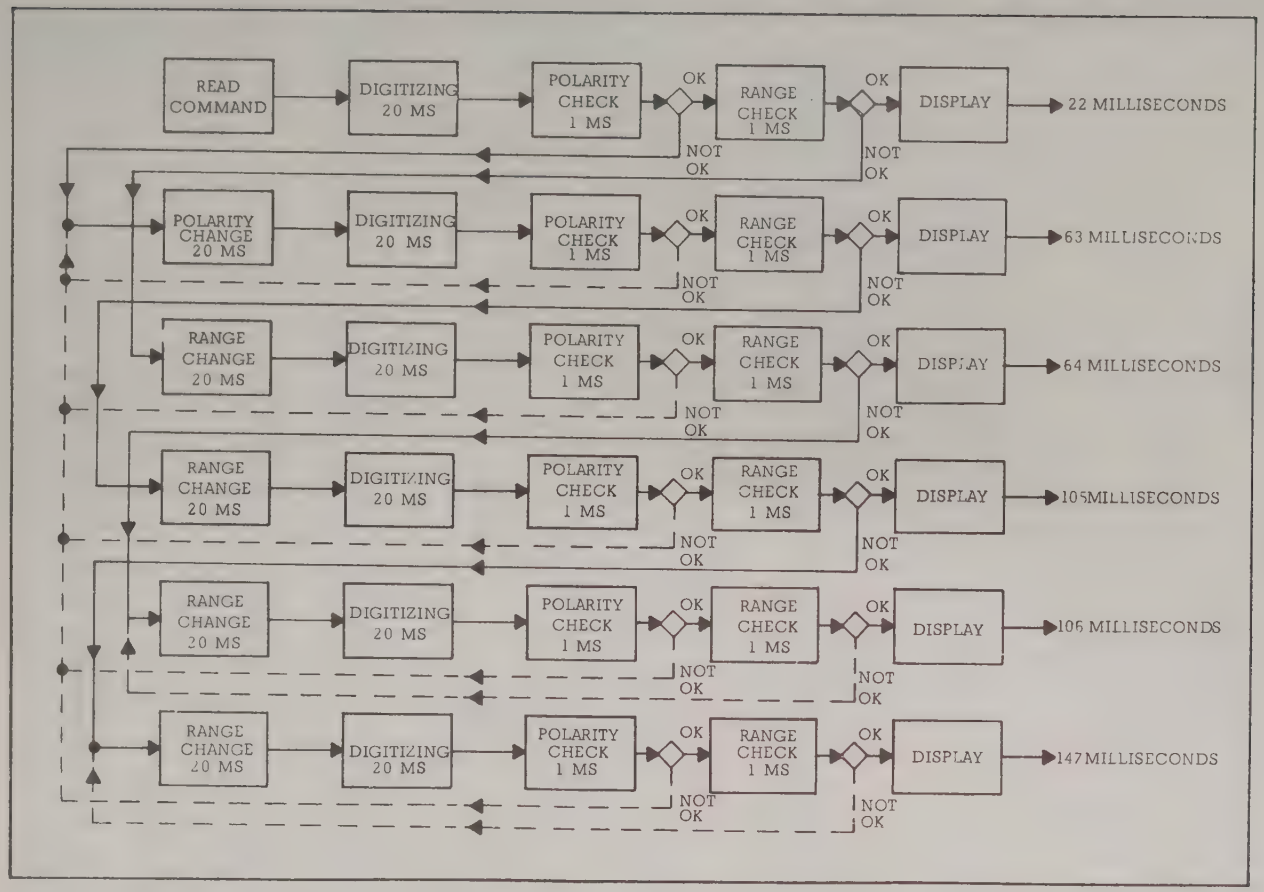


Figure 4.3 - Model 5600 READ Time

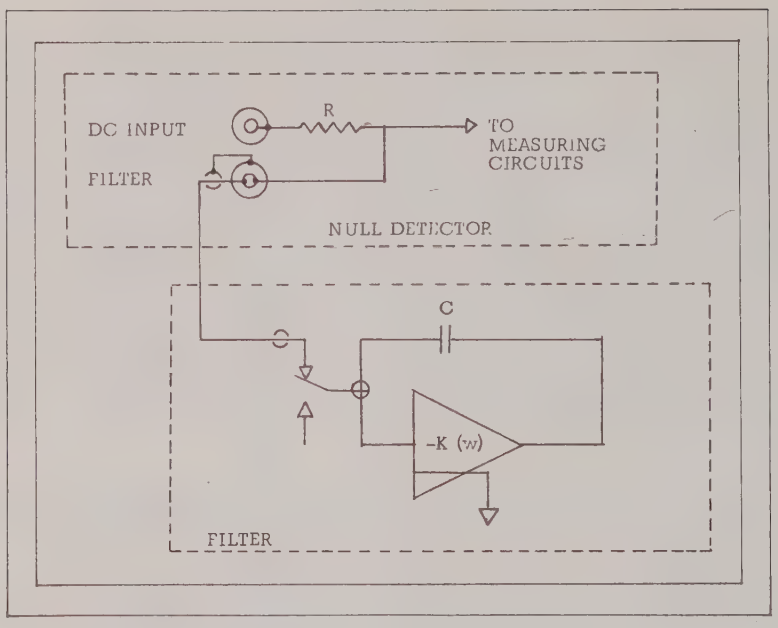


Figure 4.4 - Input Filter

AC Rejection			
Frequency	Model 55	Model 58	
60 Hz and above	37dB min	37dB/min	80dB min
300 Hz and above	80dB min	80dB/min	100dB min

Models 55 and 58 Filters include relays by which they are switched in and out of the Null Detector input circuit. In addition, a transistor switch generates a signal to the Timeout circuit on the Program circuit board to increase range and polarity delays to approximately 1-1/2 times the filter settling time.

If an active filter is not specified, the instrument is shipped with a Model 50 passive filter.

4.2.2 AC Converter

Two models of AC Converters are available. Model 20 and Model 25. They are identical except for operating frequencies. Model 20 operates from 50 Hz to 20kHz; Model 25 operates from 50 Hz to 100kHz. A simplified diagram of the AC Converter is shown in Figure 4.5.

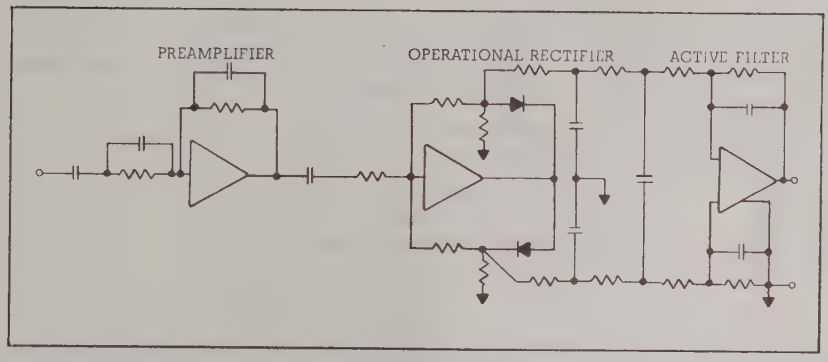


Figure 4.5 - Simplified Diagram - AC Converter

Four separate RC combinations corresponding to the four range settings are switched into the preamplifier feedback circuits by relays energized by the R1 and R2 inputs. (R1 and R2 are selected by the manual selection of range or by a decision of the Auto Range circuit.) The feedback circuit adjusts the gain of the preamplifier for the selected range.

The converter section is an operational rectifier whose output is a pulsating DC. This is filtered to a stable and precise voltage by an active filter. This DC voltage accurately represents the rms value of the input AC voltage.

There are two AC Converters in the instrument. The Converter in board position 22 is the signal converter; the Converter in position 20 functions as an external reference voltage source. Although the boards are identical, they are calibrated differently. Care must be taken not to interchange the two.

4.2.3 Preamplifier

The Model 11 preamplifier increases the sensitivity of the instrument by reducing the DC ranges of the instrument by a factor of 1000. The output is then read as millivolts rather than volts (the "1" range is not used for this function).

A simplified diagram of the preamplifier is shown in Figure 4.6. The input voltage is applied to a 400 Hz chopper. The voltage, modulated at 400 Hz, is applied to an AC carrier amplifier which delivers a current proportional to the voltage input. The output of the carrier amplifier is transformer-coupled to a demodulator. The demodulator operates on the principle of a full-wave rectifier. Each side of the secondary of the demodulator transformer is connected to the emitter of one of a pair of transistors. A 400-cycle signal from the Chopper Drive oscillator is applied to the bases. The transistors are turned on alternately with the DC output taken between the common collectors and the transformer secondary center tap.

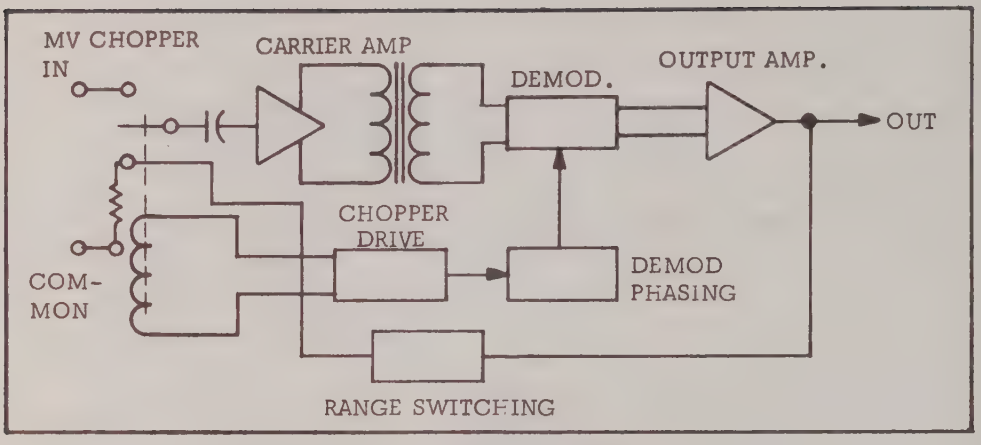


Figure 4.6 - Model 11 Preamplifier

The demodulated signal is sent to the DC output amplifier. The amplifier output is applied back to the input through relay-operated range switches. The relays are energized by the range control signals ($\overline{R1}$, $\overline{R2}$, R2) generated by manual range selection or by a decision of the Auto Range circuit.

The Chopper drive signal is generated by a 400 Hz oscillator and applied to the chopper drive coils. The same 400 Hz signal drives the Demodulator Phasing circuits. The demodulator phasing circuits phase the demodulator signals with the chopper (modulator) so that the demodulated signal corresponds to the unmodulated DC input.

4.2.4 Ohms Converter

The Ohms Converter is an operational amplifier shown simplified in Figure 4.7. The unknown resistance (R_x) is in the feedback circuit. The range resistor (R_r) is at the Amplifier input. The appropriate range resistor is switched into the circuit by relays controlled by R1, $\overline{R1}$, and R2 — resulting from either manual range selection or a decision by the Auto Range circuit — and determines the input current to the summing junction.

The current path to the unknown resistance is provided by the $\pm$ current leads to the input connector. A separate set of leads (Sense +, Sense -) senses the voltage across the unknown resistance and applies this to the amplifier input. The output voltage of the amplifier is equal to $V_{in}\, R_x/R_r$. V_{in} is applied internally to the reference input of the DVM so that the DVM readout is completely determined by the ratio R_x/R_r with R_r determined by the range selection.

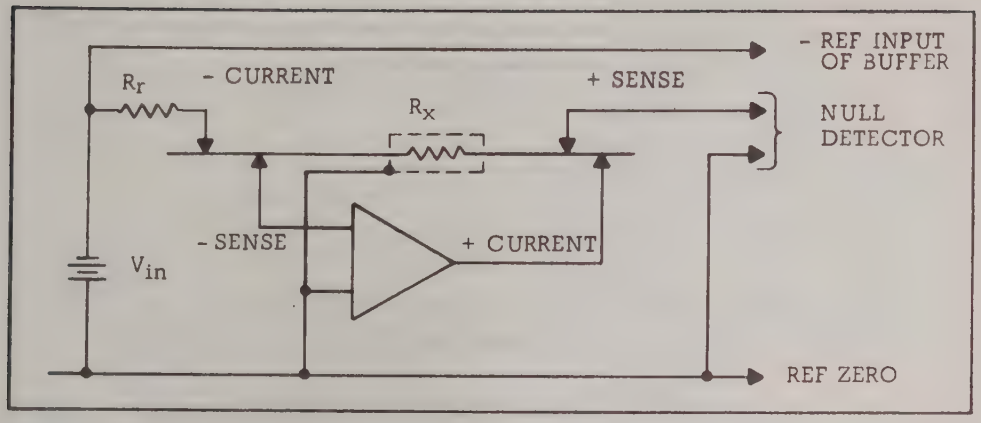


Figure 4.7 - Ohms Converter

4.3 COMPARISON VOLTAGE

4.3.1 Internal Reference Buffer (Schematic 430207)

The Internal Reference and Buffer circuit board (see Figure 4.8) has two basic elements: the internal voltage reference and the reference buffer. The reference buffer is a negative feedback potentiometric amplifier. The internal reference stabilizes the voltage output of the reference buffer to 11.000 volts (within 100 parts-per-million of a calibrated 11-volt source traceable to the National Bureau of Standards volt).

The internal reference is a divider network and a zener diode. The output of the reference buffer is the drive current for the zener diode. By careful selection of components and a balancing of resistance in the feedback circuit, a zero temperature coefficient is achieved within the operating range of the instrument.

In the ratio mode, an external reference voltage is used and the external reference source replaces the zener diode shown in Figure 4.7. The ratio between the input voltage and the amplifier output is established by the value of resistances R1 and R2. This ratio is permanently calibrated at 1.1:1. The external reference may be a battery or a DC supply at a voltage between zero and slightly over 11 volts.

The digital output of the DVM represents the ratio between the signal voltage and the reference used. If a reference of exactly ten volts is supplied, the digital output is read in volts. A fuse is provided to protect the buffer amplifier from excessive voltages.

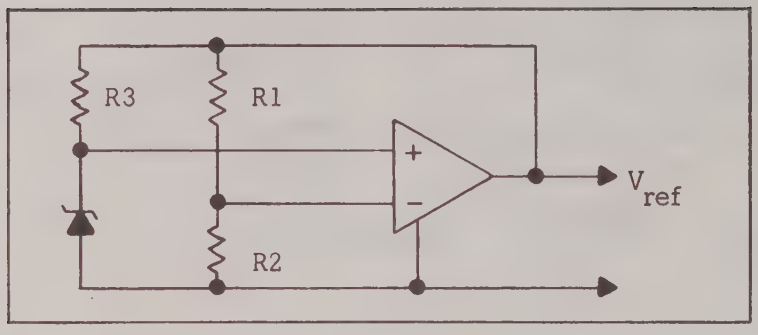


Figure 4.8 - Internal Reference and Buffer

4.3.2 Decades

Each Decade circuit board consists of a flip-flop counter, transistor switches, and DAC (Digital-Analog-Converter) resistors. The decade boards are connected as shown in Figure 4.9. One flip-flop, together with the corresponding transistor switch and DAC resistor, represents one bit position. Each decade board and each bit position in each decade is weighted according to the current each contributes to total DAC current. The current depends on the state of the corresponding flip-flop of each DAC. If the flip-flop is set, indicating a "one" for that bit position, the DAC switch is turned on and the DAC resistor is returned to either zero voltage or +11 volts depending on the polarity of the input signal. Figure 4.10 shows a typical DAC switch. With a positive input detected by the Polarity circuit on the Program board, + Enable is "true" and the DAC resistor is returned to the positive reference. With - Enable "true," the DAC resistor is returned to zero reference. In this manner, each DAC effectively "adds to" or "takes away" from the comparison voltage depending on the polarity of the input. Input to the Null Detector is always positive since the input signal is referenced to zero volts if it is positive and to +11 volts if negative (see Figure 4.11).

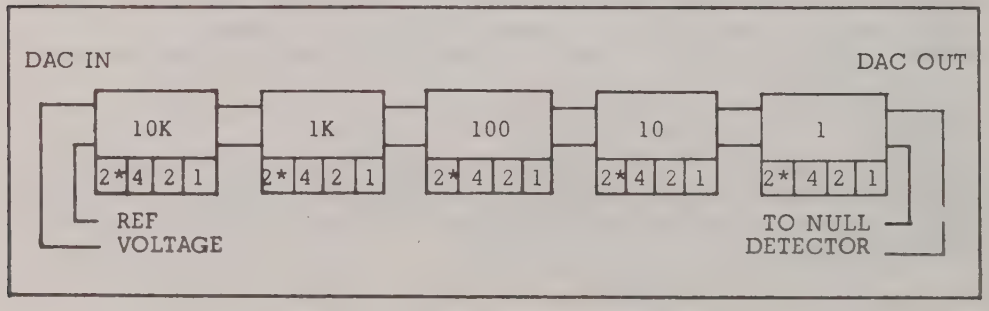


Figure 4.9 - Decade Arrangement

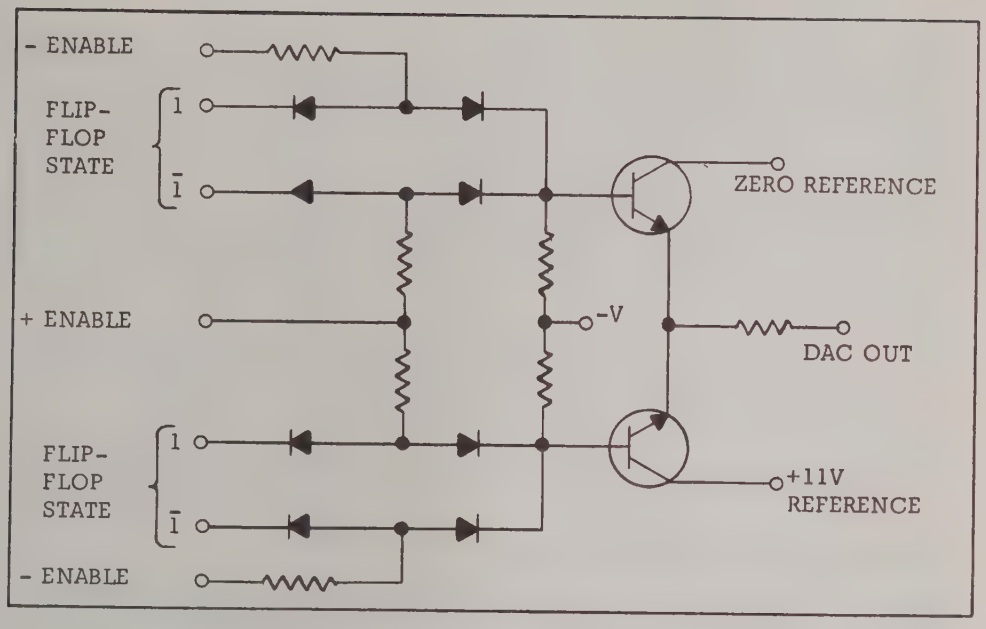


Figure 4.10 - Typical DAC Switch

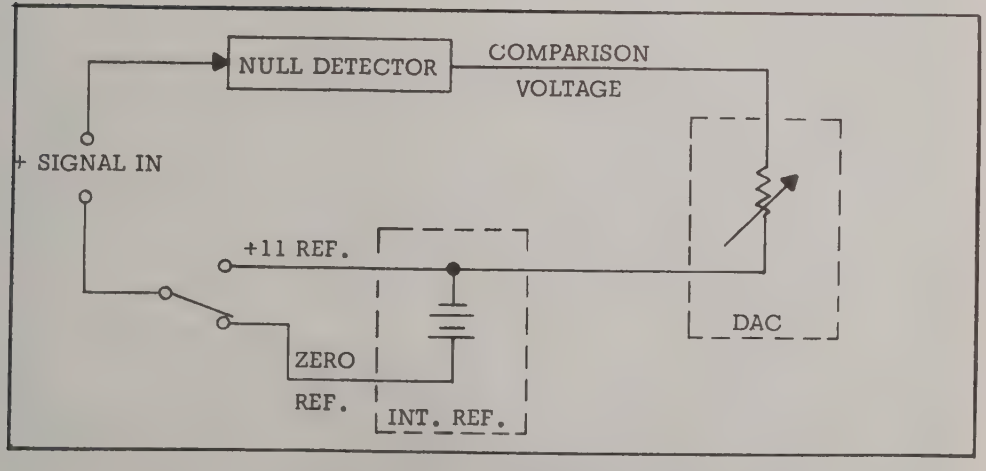


Figure 4.11 - Reference Levels

Operation of the flip-flops in the "successive approximation" sequence is controlled by signals from the Program and Auto Range boards. At the beginning of the operation, each flip-flop is set "true" representing 9 for each decade (Figure 4.12). This is done by $\overline{\text{READ}}$ from the Program board applied to the CLEAR 9 input of each decade. The clock line, tied to the reset side of each flip-flop, turns off the first (most-significant), second, third, etc., flip-flop on consecutive clock pulses. If the Null Detector finds that the bit just turned off must be restored, EXEC 1, from the Auto Range board, restores (sets) the flip-flop for that bit as the next bit is turned off. In Figure 4.12, the input signal is 62301.

Further discussions of decade control signals are included in the description of the boards on which the signals originate.

4.4 COMPARISON AND CONTROL

4.4.1 Null Detector (Schematic 430255)

A diagram of the Null Detector is shown in Figure 4.13. The preamplifier is a high-precision direct-coupled amplifier used as an input buffer. It is characterized by very low input drift and a theoretically infinite input impedance. The preamplifier is followed by another differential amplifier with a gain of ten. The error amplifier is a differential amplifier that amplifies, by many orders of magnitude, any difference between the buffered input voltage and the comparison voltage. The error amplifier can discriminate a difference of one part in 99,999 and, at the same time, indicate which signal is larger. The output of the error amplifier is converted to trigger pulses that signify when the comparison voltage be increased (UP).

The + TRIGGER and - TRIGGER signals from the Null Detector are applied to respective trigger circuits on the Program board. The trigger outputs are applied to "and" logic circuits that control the state of the Up Memory and the Down Memory flip-flops depending on the state of the Polarity flip-flop. With a + TRIGGER from the Null Detector, the Up Memory flip-flop is set when the + Polarity line is true and the Down Memory flip-flop is set when the - Polarity line is true. With a - TRIGGER from the Null Detector, Up Memory is set when polarity is negative and Down Memory is set when polarity is positive. These conditions are monitored once each clock cycle - every 1 millisecond.

Outputs of the Memory flip-flops are gated through three "and" gates; these gates maintain the $\overline{\text{READ}}$ condition until one of three conditions exists. In the tracking mode, the input signal has departed from the comparison voltage by more than one digit during a period set by the Delay Generator; this condition is sensed by the "and" gate receiving $\overline{\text{READ}}$, TRACK, and the output of either the Up Memory or Down Memory flip-flop. In the periodic mode the time delay circuit that controls the periodic rate has completed its time out. This is controlled

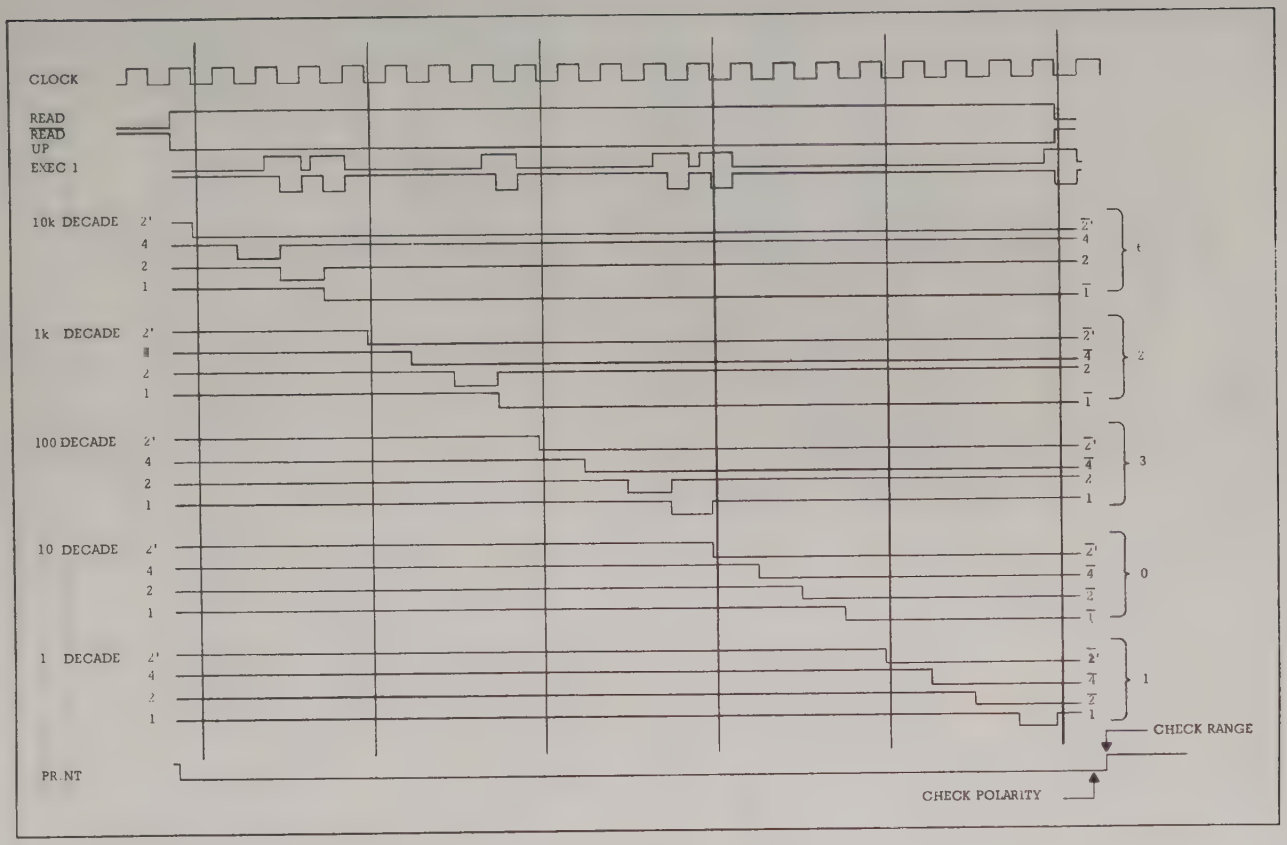


Figure 4.12 - Model 5600 Timing Diagram
(Input - 62301)

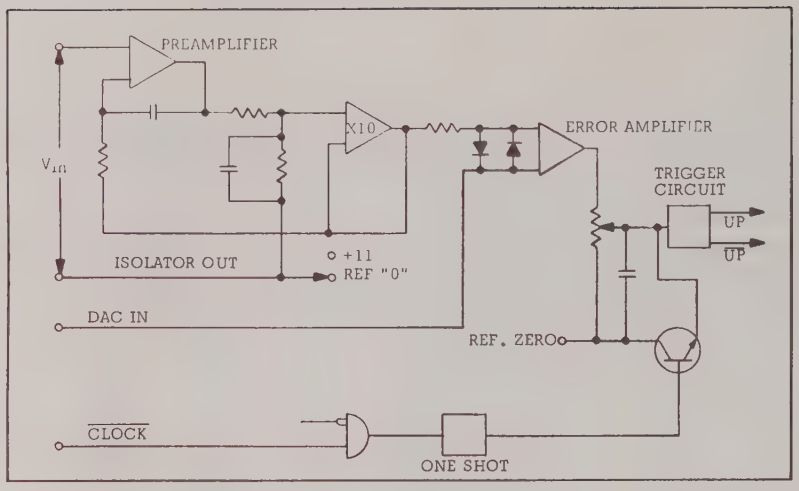


Figure 4.13 - Null Detector

by the PERIODIC and $\overline{READ}$ lines to the third gate. The third condition is an external COMMAND signal received through the programming input connector.

When one of these conditions exist, the corresponding gate is enabled and a signal is applied through an "or" gate and an inverter to the Delay Generator. The relationship of these signals to the Delay Generator and to the Read flip-flop is shown in the timing diagram of Figure 4.14.

The Delay Generator generates a delay period which, if allowed to reach completion, causes the Read flip-flop to be set. In the Periodic mode, only the Periodic and $\overline{READ}$ signals are required to start the delay. Both of these signals are "true" until Read is generated. Therefore, in this mode, the delay runs to completion and triggers the Read flip-flop commanding a new reading at intervals determined by the setting of the RATE control on the front panel. The delay period can be adjusted from approximately 20 milliseconds to 1 second.

In the Tracking mode, three signals are required to start the delay period: Track (indicating tracking mode), $\overline{READ}$ (indicating Read flip-flop is not set), and UP or DOWN (from the Memory flip-flops). The "true" level exists as long as an error in one direction is detected. The first error signal, shown on line 7 of the timing diagram starts the delay since Track and Read remain "true" until Read is set. In this case, the Delay Generator is reset before the completion of the Delay period; READ is not set. The same is true for the second and third error signals. The fourth error signal is "true" for a sufficient time to allow the delay to run to completion and command a new reading.

The effect of the RATE control in the Tracking mode is to vary the time interval during which a continuous error must occur in order to cause a new reading to be taken. With a minimum delay, a continuous error of one digit or more during a period of approximately 20 milliseconds will trigger Read. This is illustrated in

Figure 4.15 which shows, on line 6, the delay generator set for a relatively long delay period. Line 8 shows the generator set for a shorter delay period. Note that three new readings are taken with the shorter delay and none with the longer delay.

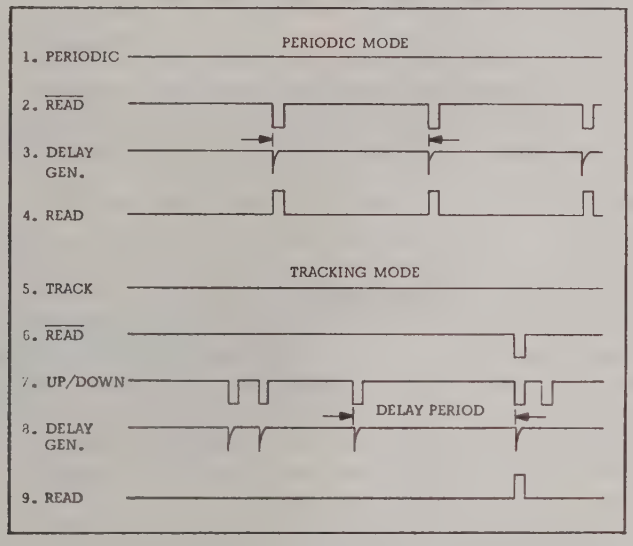


Figure 4.14 - READ Generation Timing

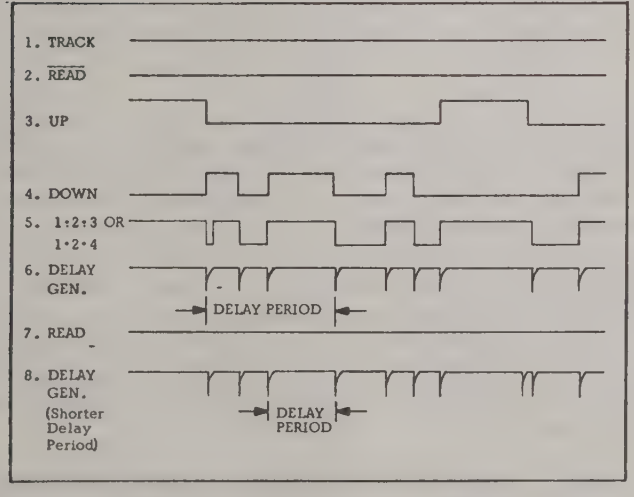


Figure 4.15 - Tracking Sensitivity

The Timeout Generator inhibits the generation of Read during the periods of range and polarity changes and allows for the settling time of various input accessories. Input logic to the READ, Timeout, and Delay circuits receive other control inputs to handle various conditions and sources of command. For example, the delay generator can be held "off" by a Hold signal from the control panel. The remote programming $\overline{\text{COMMAND}}$ input sets the Read flip-flop directly.

At the end of each digitizing operation, the polarity must be checked. If the digitizing was accomplished with the wrong polarity, the decades will all be set to zero and the Null Detector will generate a down signal. A seven-input "and" gate at the input to the Polarity flip-flop receives signals representing the zero state of each of the five decades. Its output enables a second level "or" gate causing the Polarity flip-flop to change state. The reference voltage is then reversed (see Figure 4.11).

4.4.2 Auto Range (Schematic 430166)

A test is performed at the end of each digitizing operation (after the polarity check) to verify that the instrument is on the proper range. The need for a range change is determined by "and" logic circuits on the Auto Range board that detect one of two conditions: a 9 on each decade (99.999) along with an UP signal, or a 9 on decades 1, 3, and 4 with zeros in decades 2 and 5 (09.909).

Signals from the "and" gates are applied to a counter consisting of the two Range flip-flops. The signal from the "all nines" gate, indicating a reading near full scale for that range, drives the counter to the $\overline{R1}$ - $\overline{R2}$ state (both reset). This condition commands the range switching circuits throughout the instrument to switch to the highest range. An advancing count represents a lower range, i.e. 00 is the 1000 range, 01 is 100 range, 10 is 10 range, and 11 is the 1 range. The signal from the 09.909 gate, indicating less than 10% of full scale reading, flips the counter to the next lower range.

EXECUTE 1 is generated on the Auto Range board as a result of the UP signal from the Null Detector. The flip-flops on the Decade boards are all set "true" on the first clock pulse after READ is generated. The flip-flop in the most significant bit position is reset by the next clock. The Null Detector then determines whether the comparison voltage is now greater or less than the input voltage. If it is greater, the most significant flip-flop remains "false" and the flip-flop in the next most significant bit position is reset on the next clock. If, however, the Null Detector found that the comparison voltage is less than the input voltage, it generates the UP signal. EXECUTE 1 is generated (as a result of UP) to restore (set) the flip-flop in the most significant bit position on the same clock that resets the next flip-flop. EXECUTE 1 is generated on each subsequent UP signal to restore the previous bit.

An additional gate at the input to the EXECUTE 1 inverter causes an Execute 1 to be generated as a result of states of the Memory Control and Memory flip-flops.

Inputs to this circuit are "9" counts from each of the Decades. The purpose of the circuit is to eliminate "forbidden codes."

4.5 READOUT CIRCUITS

The Digit and Function Readout boards contain diode logic circuits that translate the binary coded decimal value of each Decade board to digital form. The outputs control a transistor switch that lights the appropriate element in the Nixie display tube.

One Digit Readout board receives data from the 1 and 10 Decade boards; another Digit Readout receives data from the 100 and 1000 Decades. The Function Readout board receives data from the 10k decade and also handles the function information to be displayed; decimal point placement, polarity indication, ranging symbol R, and the AC or Ohms symbol. The circuit for a typical decade is shown in Figure 4.16.

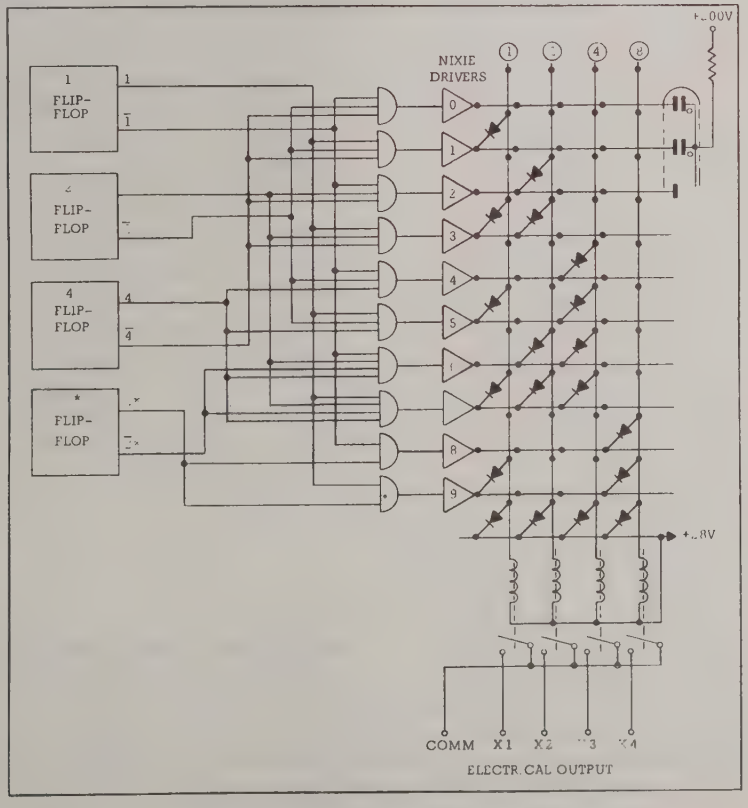


Figure 4.16 - Readout/Printout Circuits

If an instrument equipped for optional electrical output, the lines to the Nixie displays are also applied to a diode matrix which delivers a binary coded decimal output in any desired format. This output is for the use of a printer or other recording device. A similar diode matrix converts the function information. Typical output formats were shown in Figure 2.2.

Section 5

Troubleshooting And Calibration

5.1 GENERAL

The ideal method of troubleshooting is substitutional checking — in which a circuit board known to be operating is substituted for a board suspected of malfunctioning. The probable cause can usually be localized to one or two boards. When the board causing the malfunction is located, an extender assembly can be used to enable further troubleshooting of the board while operating in the unit. This assembly includes the extender board, support bracket, and extension cable. If a second instrument is available, individual boards can be borrowed to double-check the diagnosis or for use as temporary spares until new boards are received from the factory.

5.2 DELETED

5.3 TROUBLESHOOTING PROCEDURES

Certain types of troubles can be quickly located because of obvious symptoms. For example, power failure results in a totally blank display. If the fan is not operating, the trouble is either lack of input power or a blown power fuse on the instrument. If the fan is operating, the power supply is faulty and must be removed for repair.

If the instrument fails to measure a particular function but measures all other functions properly, the trouble probably lies on the board which provides signal conditioning for that function.

Function Not Operating	Replace Board
AC	AC Converter (Signal Converter)
Ohms	Ohms Converter
Millivolts	Preamplifier

5.4 TROUBLE SHOOTING CHARTS

If symptoms are such that the trouble source is not as obvious as those listed above, refer to the troubleshooting charts (Figures 5.1 through 5.5).

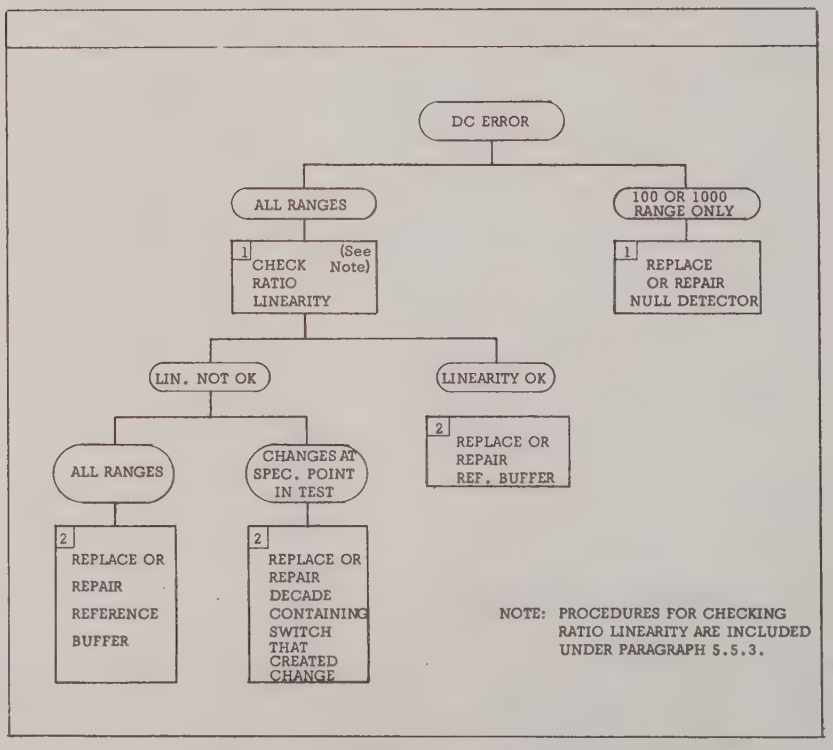

DC ERROR
ALL RANGES
100 OR 1000 RANGE ONLY
1 CHECK RATIO LINEARITY (See Note)
1 REPLACE OR REPAIR NULL DETECTOR
LIN. NOT OK
LINEARITY OK
2 REPLACE OR REPAIR REF. BUFFER
ALL RANGES
CHANGES AT SPEC. POINT IN TEST
2 REPLACE OR REPAIR REFERENCE BUFFER
2 REPLACE OR REPAIR DECADE CONTAINING SWITCH THAT CREATED CHANGE
NOTE: PROCEDURES FOR CHECKING RATIO LINEARITY ARE INCLUDED UNDER PARAGRAPH 5.5.3.

Figure 5.1 - Troubleshooting — DC Error

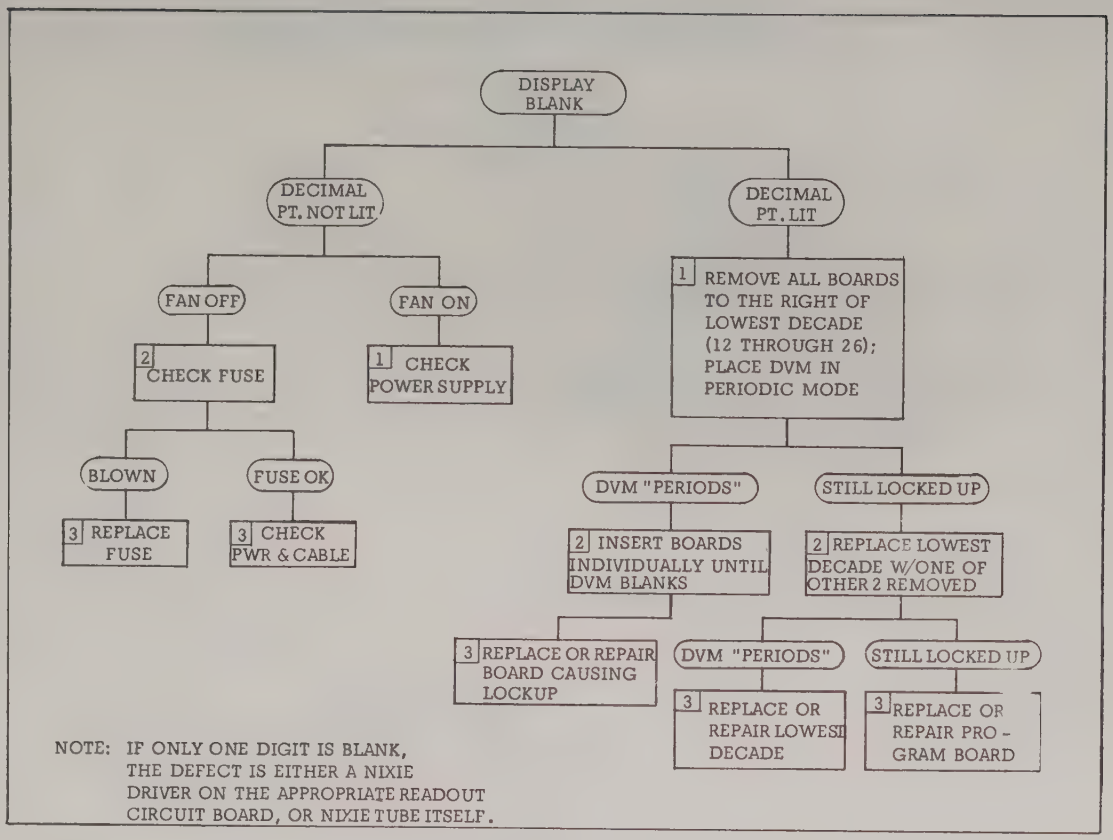

DISPLAY BLANK
DECIMAL PT. NOT LIT
DECIMAL PT. LIT
FAN OFF
FAN ON
2 CHECK FUSE
1 CHECK POWER SUPPLY
1 REMOVE ALL BOARDS TO THE RIGHT OF LOWEST DECADE (12 THROUGH 26); PLACE DVM IN PERIODIC MODE
BLOWN
FUSE OK
DVM "PERIODS"
STILL LOCKED UP
3 REPLACE FUSE
3 CHECK PWR & CABLE
2 INSERT BOARDS INDIVIDUALLY UNTIL DVM BLANKS
2 REPLACE LOWEST DECADE W/ONE OF OTHER 2 REMOVED
3 REPLACE OR REPAIR BOARD CAUSING LOCKUP
DVM "PERIODS"
STILL LOCKED UP
3 REPLACE OR REPAIR LOWEST DECADE
3 REPLACE OR REPAIR PRO - GRAM BOARD
NOTE: IF ONLY ONE DIGIT IS BLANK, THE DEFECT IS EITHER A NIXIE DRIVER ON THE APPROPRIATE READOUT CIRCUIT BOARD, OR NIXIE TUBE ITSELF.

Figure 5.2 - Troubleshooting — Display Blank

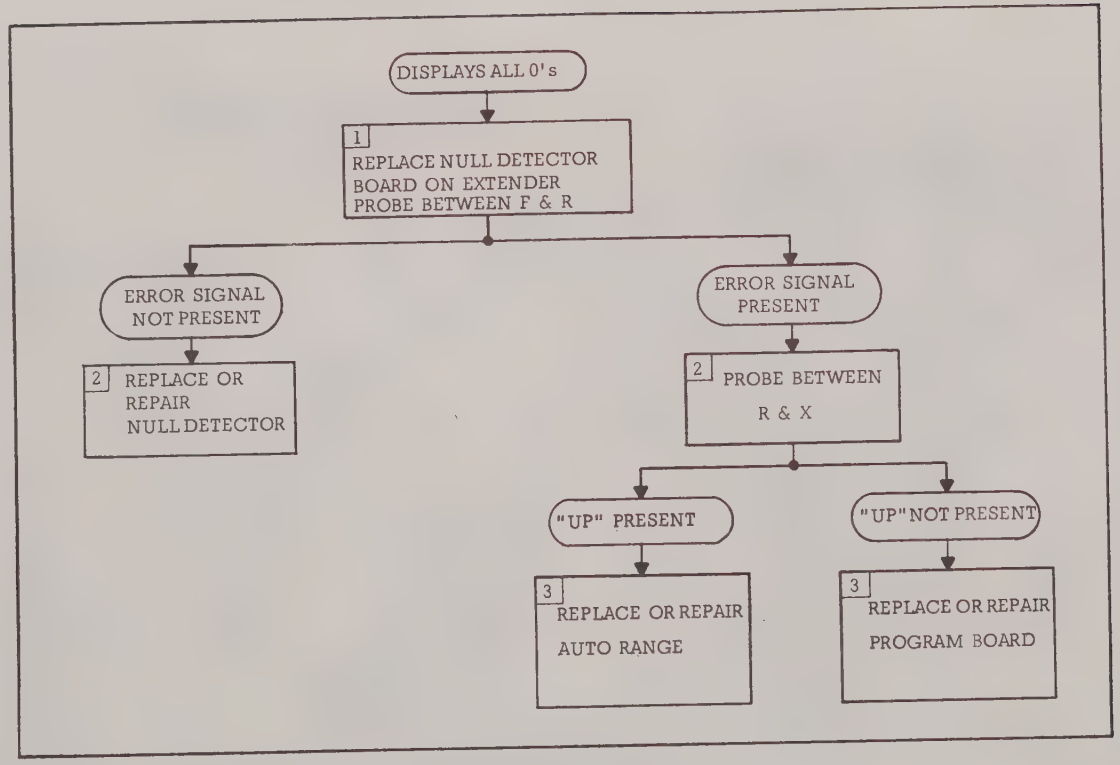


Figure 5.3 - Troubleshooting — Displays All Zeros

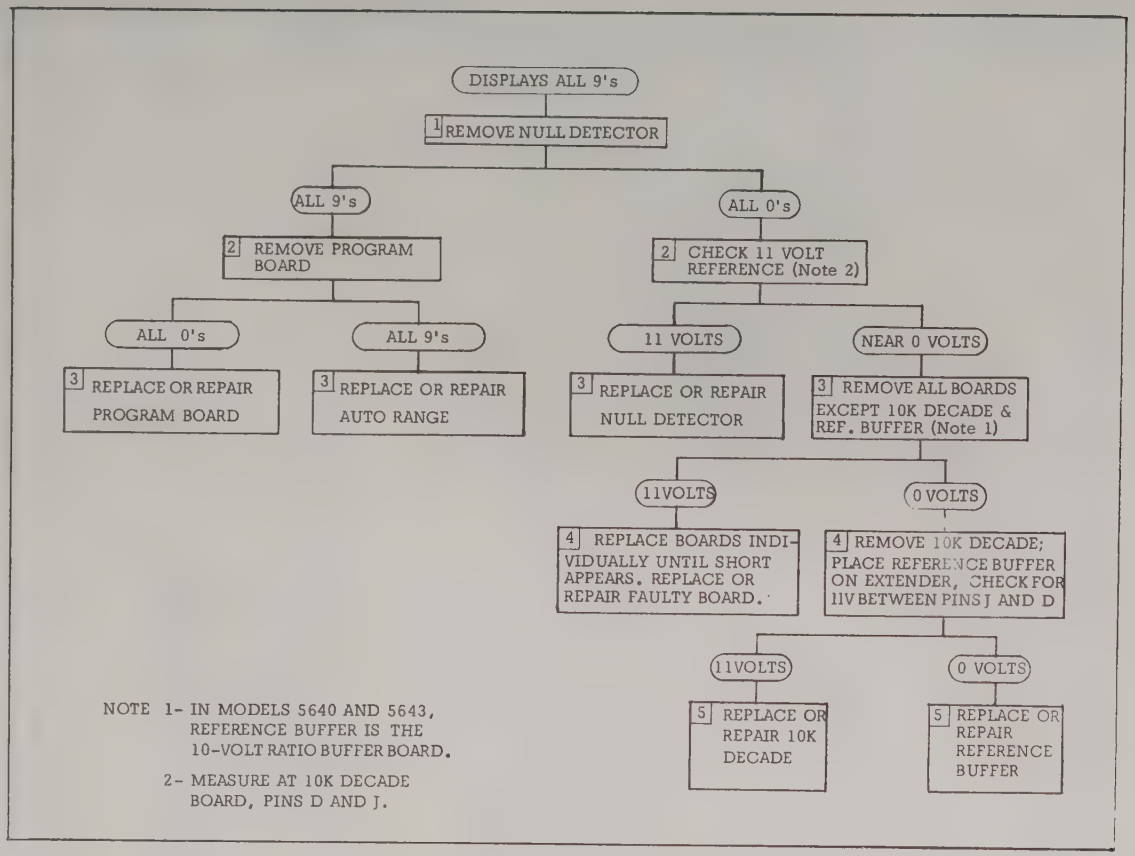

DISPLAYS ALL 9's
1 REMOVE NULL DETECTOR
ALL 9's
ALL 0's
2 REMOVE PROGRAM BOARD
2 CHECK 11 VOLT REFERENCE (Note 2)
ALL 0's
ALL 9's
11 VOLTS
NEAR 0 VOLTS
3 REPLACE OR REPAIR PROGRAM BOARD
3 REPLACE OR REPAIR AUTO RANGE
3 REPLACE OR REPAIR NULL DETECTOR
3 REMOVE ALL BOARDS EXCEPT 10K DECADE & REF. BUFFER (Note 1)
11VOLTS
0 VOLTS
4 REPLACE BOARDS INDIVIDUALLY UNTIL SHORT APPEARS. REPLACE OR REPAIR FAULTY BOARD.
4 REMOVE 10K DECADE; PLACE REFERENCE BUFFER ON EXTENDER, CHECK FOR 11V BETWEEN PINS J AND D
11VOLTS
0 VOLTS
5 REPLACE OR REPAIR 10K DECADE
5 REPLACE OR REPAIR REFERENCE BUFFER
NOTE 1- IN MODELS 5640 AND 5643, REFERENCE BUFFER IS THE 10-VOLT RATIO BUFFER BOARD.
2- MEASURE AT 10K DECADE BOARD, PINS D AND J.

Figure 5.4 - Troubleshooting — Displays All Nines

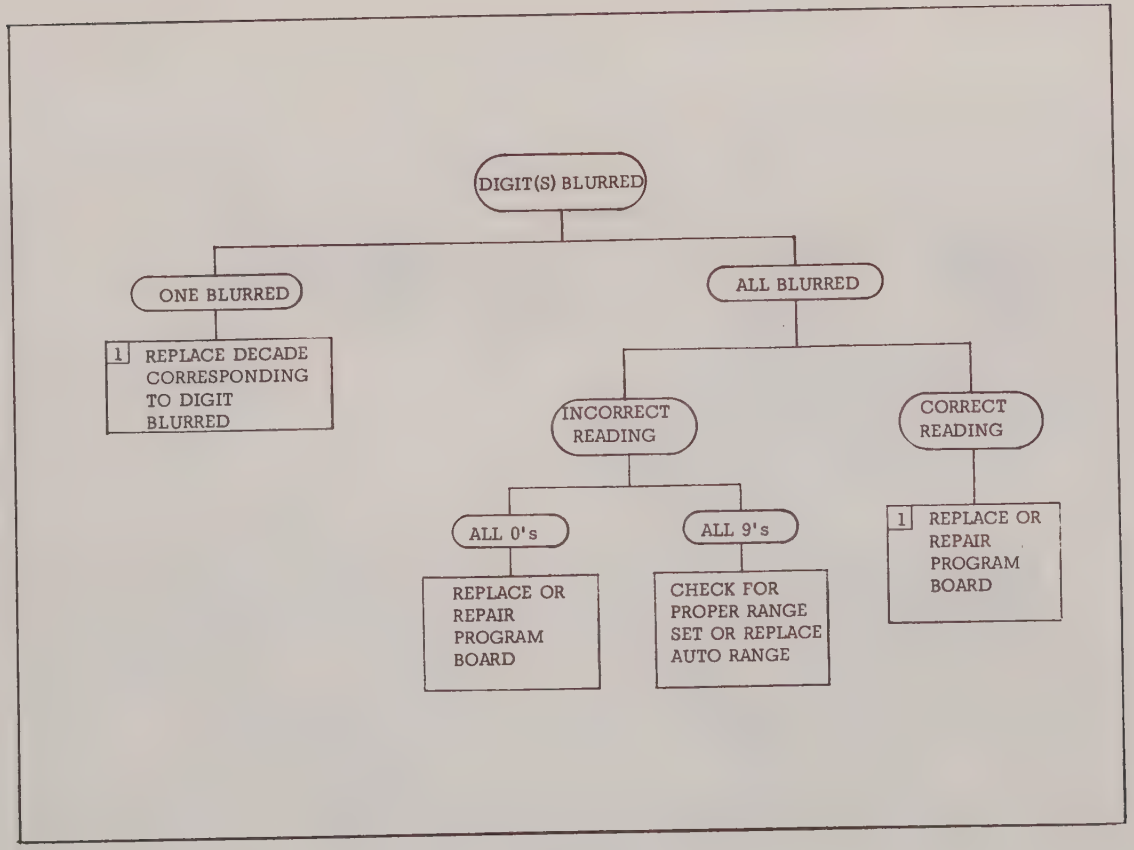


Figure 5.5 - Troubleshooting — Digits Blurred

5.5 MAINTENANCE CALIBRATION (For Calibration Procedures, See TB 750-236)

5.5.1 Schedule

The Internal Reference Voltage of the Dana Model 5600 is guaranteed to vary or drift less than 100 ppm (0.01%) during any consecutive six months, starting within the guarantee period. The linearity of the instrument, defined as its ability to produce digital data that bears an exact linear relationship to either the internal reference voltage or an external reference, is calibrated at the factory for the life of the instrument. No subsequent adjustments are required, nor are any provided.

The result is a sharp reduction in both the frequency and the complexity of recalibration, compared to other instruments of this type. However, the user's company policy may require monthly or other more frequent calibration checks as a matter of routine. Moreover, the user may wish to make a number of checks during the first few months that the instrument is in service in order to obtain assurance that the instrument is meeting its stability specifications.

A unique feature of the Dana Model 5600 is that the precise setting of the internal reference voltage calibration vernier may be determined by setting the controls to perform Test B. The quantitized value may be read on the Nixie display and recorded on a calibration log provided on the instrument. It is therefore possible to obtain an exact historical record of the instrument's stability performance. This in turn can be used to establish recalibration schedules that are based on the actual requirements of the instrument.

5.5.2 Procedure

The usual procedure is to remove the instrument from its rack or laboratory bench location and take it to a Standards Laboratory for the recalibration check. However, since the entire procedure is performed through the front panel opening, it is possible to recalibrate the instrument without removing it from its rack.

The Internal Reference and Buffer circuit board is the only portion of the null balance circuitry that requires periodic adjustment. All other variables, including zero point, decade dividers, and range ratios, are calibrated at the factory and fixed for the life of the instrument.

The Internal Reference is calibrated by a single screwdriver adjustment through an opening behind the right-hand front-panel door. A seal may be used to close off the hole to prevent unauthorized changes in the calibration setting. In general, the following recalibrations should be conducted by authorized Standards

personnel. Also, for optimum accuracy, the instrument should always be calibrated against a voltage standard that is traceable to the National Bureau of Standards.

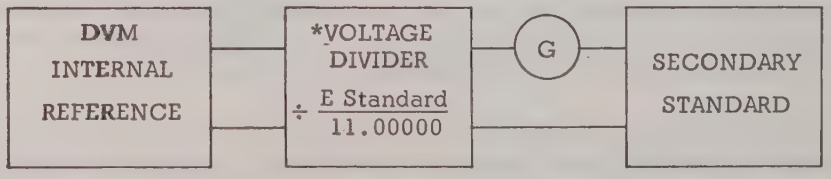
1. Remove the interboard connection and insert the recalibration test leads into the socket provided on the front of the 10k Decade (position 15). The voltage across these two leads is the output of the Buffer Amplifier, and the objective of the recalibration procedure is to adjust this voltage to exactly 11.0000 volts.

2. Connect test setup as shown in Figure 5.6. The secondary standard and voltage divider should have an assured accuracy of at least one order of magnitude greater than that of the instrument, or 0.001%. The galvanometer should be of comparable precision. Set the voltage divider so that the 11.000 volts from the internal reference would be divided to a voltage exactly equal to the secondary standard if the instrument were in calibration.

3. Adjust the Internal Reference vernier, located on the front of the Reference Buffer board (position 18), until an exact null balance is achieved.

4. Remove the test leads and set the instrument to the Test B mode. The new setting of the calibration vernier will be displayed in volts on the instrument readout. Write the data and setting on the calibration log located immediately behind the left front panel section. Figure 5.7 shows a typical calibration log for an instrument that has been in service for one year. Observing the Test B readings, it would appear that the instrument exhibited considerable drift; however this is not the case since Test B is effectively a large magnification of the calibration vernier setting. The sample instrument actually shifted less than 50 ppm during the one-year period. The actual drift is determined by comparing the difference between the Test B readings in millivolts with the factory notation on the Calibration log indicating the number of millivolts variance allowable within the 100 ppm stability specification (e.g., 100 ppm = 115 millivolts).

The above notation is unique for each instrument as is the resolution of the calibration adjustment. Regarding the latter, the resolution of the calibration control should not be confused with the number of digit changes in the Test B reading.



*100,000 Ohms Minimum

Figure 5.6 - Recalibration Circuit

Reference must always be made to the change in millivolts (last two digits of Test B Reading may be disregarded if desired). The actual resolution of the calibration control is sufficient to set the reference to within 20 ppm of a secondary standard. Experience has indicated that the calibration drift is not linear with time. It is not possible, therefore, to extrapolate the six-month stability from the data gained during the first few recalibrations. Dana's guarantee is that during any six consecutive months the total departure from any previous setting will be within the 100 ppm limit.

CALIBRATION LOG
SERIAL NO. 035600
100 ppm = 355 mv

Date	Test A Volts	Test B Volts	Cal By
11/13/4	6.3481	5.4289	MP
12/12/4	6.3480	5.4321	MP
1/15/5	6.3481	5.4402	MP

Figure 5.7 - Typical Calibration Log

At the same time that the Test B reading is recorded, it is advisable to read and record the Test A value. The Test A reading is only a rough check on the operation of the instrument; however, it should remain stable within 10 digits so long as the Internal Reference stays within its stability specifications.

5.5.3 Linearity Check

No adjustments are required or provided for calibration of linearity. However, the user may want to check the linearity of the instrument from time to time in order to satisfy himself that there has been no change in the component values.

1. Connect circuit for this test as shown in Figure 5.8. The instrument is operated in the Ratiometer mode to eliminate any variables due to the instability

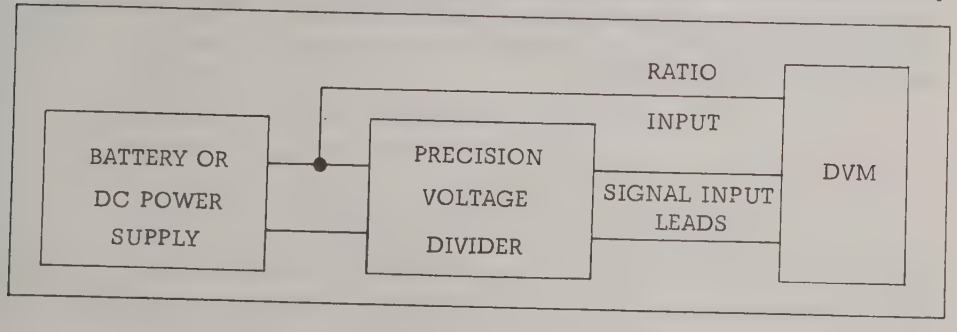


Figure 5.8 - Circuit for Testing Linearity

in the power source. The comparison is between the settings of the precision voltage divider and the instrument. These should agree within the Ratio specification,

$$0.002 \pm \frac{(10V)}{(E_{ref})} \quad (.001\% \text{ of Full Scale, or about } 0.003\%)$$

of full scale with a 10 volt reference.

2. Using appropriate power sources, check linearity on all three ranges. Take care to avoid loading due to the 10 megohm input attenuator on the higher ranges.

5.5.4 AC Reference Recalibration

The AC/DC Converter is calibrated as described in the Accessory Manual.

PARTS PROVISIONING INFORMATION

6. REPLACEMENT PARTS

To obtain replacement parts, find the manufacturer's part number and description in this manual and then refer to the appropriate Repair Parts and Special Tools List (RPSTL) TM. In the RPSTL, find the assembly or subassembly first and then the description which corresponds with that in this manual. Under the description in the RPSTL find the manufacturer's part number, and then order the part by the listed Federal Stock Number. If the part is not listed in the RPSTL, it should be requisitioned from the NICP in accordance with AR 725-50.

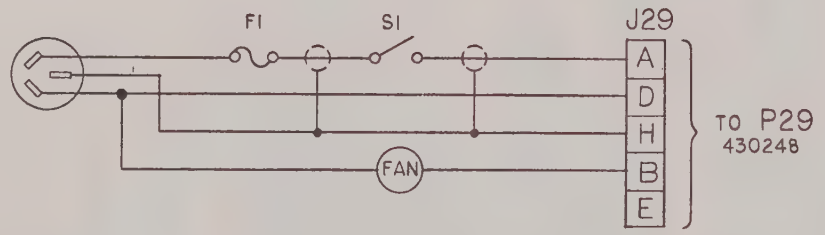
Section 6

DRAWINGS AND PARTS PROVISIONING LIST

NOTE: See information on page 5-10.

Drawing	Title
430377	Schematic - Primary Wiring - 5600
430248	Schematic - Power Supply
430247	Wiring Diagram - Power Supply
430169	Wiring Diagram - Control Panel
430162	Wiring Diagram - Card Box
400370	PC Board Assembly - Internal Reference and Buffer
430207	Schematic - Internal Reference and Buffer
400461	Null Detector Assembly
400439	PC Board Assembly - 5600 Null Detector Main 5 Digit
400438	PC Board Assembly - Null Detector Isolator 5 Digit
430255	Schematic - Null Detector 5 Digit
400258	PC Board Assembly - 10,000 Decade - 5 Digit
430065	Schematic - 10,000 Decade - 5 Digit
400435	Board Assembly, 1000 Decade - 5 Digit
430250	Schematic - 1000 Decade - 5 Digit
400436	Board Assembly - Lower Order Decade
430251	Schematic - Lower Order Decade
400296	PC Board Assembly - Model 5600 Program Board
430163	Schematic - Model 5600 Program Board
400297	PC Board Assembly - Auto Range
430166	Schematic - Auto Range
400463	PC Board Assembly - Basic Digit Readout
430271	Schematic - Digit Readout
400467	PC Board Assembly - Readout Board
430272	Schematic - Function Readout
430259	Wiring Diagram - Readout
190180	Schematic, Printer H1-S-638
190181	Wiring Diagram, H1-S-638
190182	PCB Assembly, H1-S-638
190183	Printer Driver Assembly, H1-S-638
190186	Schematic, Printer Matrix
191162	PCB Assembly, Function Readout Matrix H1-S-638
400870	PCB Assembly, Digit Readout Matrix

NOTES:



QTY REQD	SYM	ITEM NO.	GOV'T IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION

LIST OF MATERIALS OR PARTS LIST

400660	5600	REF	REF
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA—SUB—ASSY MRA—MAJOR REPL ASSY
MA—MODULE ASSY CA—COMPLETE ASSY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: .X ± .030, .XX ± .020, .XXX ± .010
ANGLES ± 0° 30'

MATERIAL

APPLIED FINISH

DRAWN	U. LOVELESS	3-3-66
CHECK	D. French	9 MAR 66
ENGR	W. Gibbs	3/66
APPR		

APPROVED

APPROVED

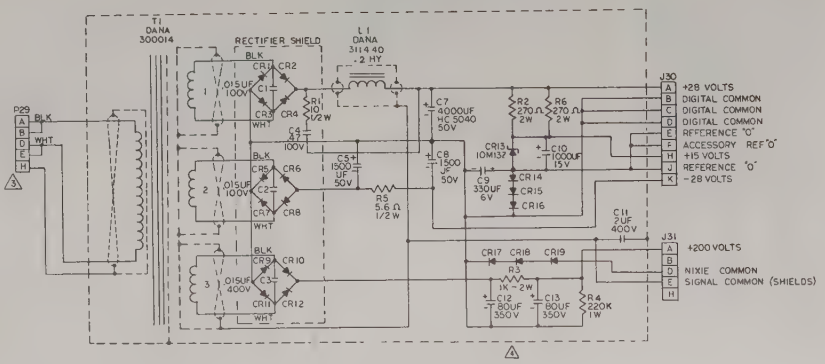
Rel 4-1-66
DRW #354 BB

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC PRIMARY WIRING 5600-5640

CODE IDENT NO.	SIZE	
	B	430377

SCALE — WEIGHT SHEET 1 OF 1



⚠ C12 AND C13 ARE A DUAL CAPACITOR

3. Highest reference designators are; MP, C13, CR19, TP4, L1, P29, and J31

2. All diodes, except CR 13 are located in the rectifier shield

1. All diodes are 1N3194

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	SYM	ITEM NO	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS: X ± .030, XX ± .020, XXX ± .010
ANGLES ± 0° 30'
FORMED ANGLES ± 1.0°
ECCENTRICITY BETWEEN DIA ON THE SAME AXIS SHALL NOT EXCEED .010 TIR.
INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL-D-1000 AND MIL-D-70327

CONTRACT NO.

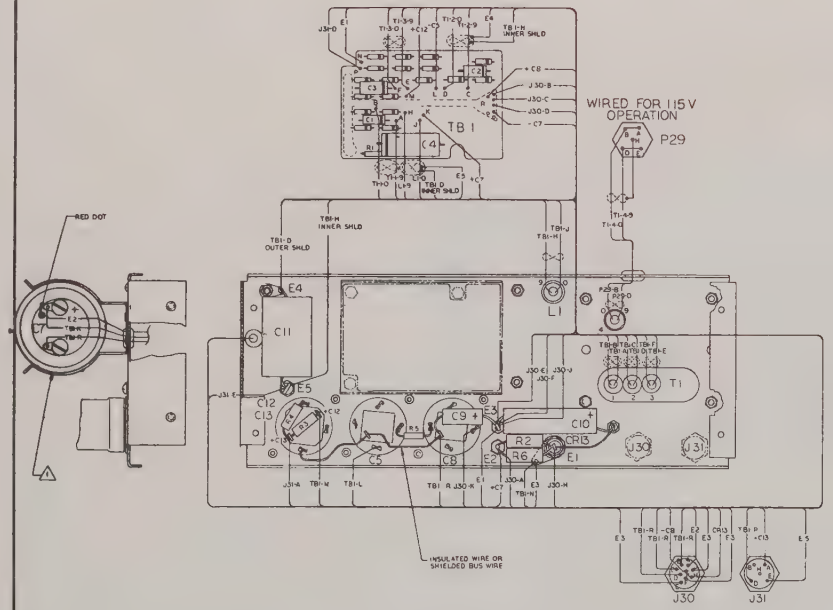
	NAME	DATE
DR	[illegible]	11-15-65
CHK	[illegible]	11/16/65
APPD		
Revised per ECR 122		4-21-66
Revised per ECR 122		9-15-65

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC – POWER SUPPLY 5600

SIZE	CODE IDENT NO.	DWG NO.
D	21793	430248 F

SCALE-NONE WT SHEET 1 OF 1



FROM	TO	WIRE COLOR
TB 1-K	+ C 7	WHT-RED-GRY
TB 1-L	- C 5	WHT-ORG-WHT
TB 1-M	+ C 12	WHT-RED-BLK
TB 1-N	E 1	BLACK
TB 1-P	J-31-D	WHT-BRN-BLU
TB 1-R	+ C 8	BLK-WHT
TB 1-S	J-30-B	BLK-WHT
TB 1-T	J-30-C	BLK-WHT
TB 1-U	- C 7	BLK-WHT
TB 1-V	J-30-D	BLK-WHT
TB 1-D INNER SHIELD	TB 1-W INNER SHIELD	WHT-BRN-RED
TB 1-D OUTER SHIELD	E 4	WHT-BRN-GRN
+ C 7	E 2	WHT-RED-GRY
E 1	E 3	BLACK
J-30-A	E 2	WHT-RED-GRY
J-30-E	E 3	BLACK
J-30-F	E 3	BLACK
J-30-H	CR 13	RED-BRN-GRN
J-30-J	E 3	BLACK
J-30-K	- C 8	YIO-RED-GRY
J-31-A	+ C 13	WHT-RED-BLK
J-31-B	-----	-----
J-31-E	E 5	WHT-BRN-RED
J-31-H	-----	-----
+ C 8	+ C 5	BLK-WHT
+ C 5	- C12/C13	BLK-WHT

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	
1				400928		
1				400922		
1				400921		
1				400914-400434		

NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY

APPLICATION | QTY REQD

SYMBOLS: APPLICABLE TO DANA LABORATORIES INC. ONLY. SA—SUB-ASSY MA—MODULE ASSY MFR—MAJOR REPL ASSY CA—COMPLETE ASSY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON DECIMALS: X ± .030, .XX ± .020, .XXX ± .010. ANGLES ± 0° 30'

MATERIAL

APPLIED FINISH

DRAWN | CHECK | ENGR | APPR | APPROVED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

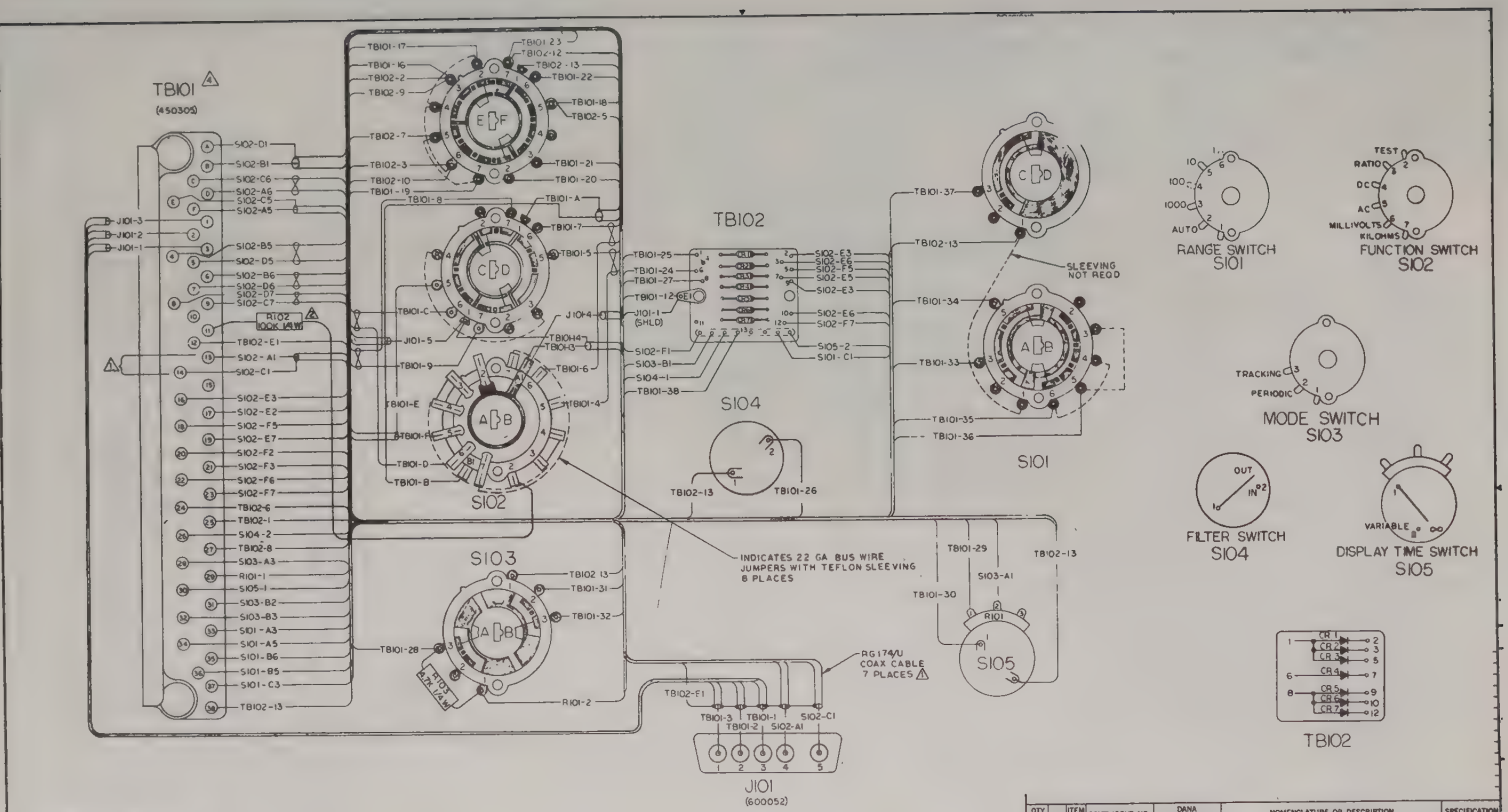
WIRING DIAGRAM
POWER SUPPLY 5600

CODE IDENT NO. | SIZE D | 430247 | C

SCALE --- | WEIGHT | SHEET 1 OF 1

⚠ CAPACITOR C7 TO BE WRAPPED WITH MYLAR TAPE BEFORE INSTALLATION.

NOTES: UNLESS OTHERWISE SPECIFIED



5. SWITCHES ARE IN EXTREME COUNTER CLOCKWISE POSITION; VIEWED FROM REAR.

2. TB 101 IS CONNECTED, VIA FLEXPRINT, AS FOLLOWS.
   TB 101 - PIN 'A' THRU 'F' TO SIGNAL AND ACCESSORY CONNECTOR(S)
   TB 101 - PIN 1 THRU 30 TO P27 - PIN 1 THRU PIN 30 RESPECTIVELY

3. ALL WIRES ARE 24 GA, PVC, HOOK-UP

4. R102 SHALL BE ROUTED INDEPENDENT OF TIED WIRE BUNDLE AND POSITIONED FOR MAXIMUM CLEARANCE AND ACCESS. LEADS SHALL BE INSULATED WITH TEFLON SLEEVING

5. TERMINALS 13 AND 14 ARE WIRED ONLY WHEN REAR INPUT CONNECTOR OPTION IS REQUIRED

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	SYM	ITEM NO	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	

40603	36400	REF	REF
NEXT ASSY	USED ON	NEXT ASSY/FINAL ASSY	
APPLICATION		QTY REQD	

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC ONLY
SA—SUB-ASSY MRA MAJOR REPL ASSY
MA MODULE ASSY CA—COMPLETE ASSY

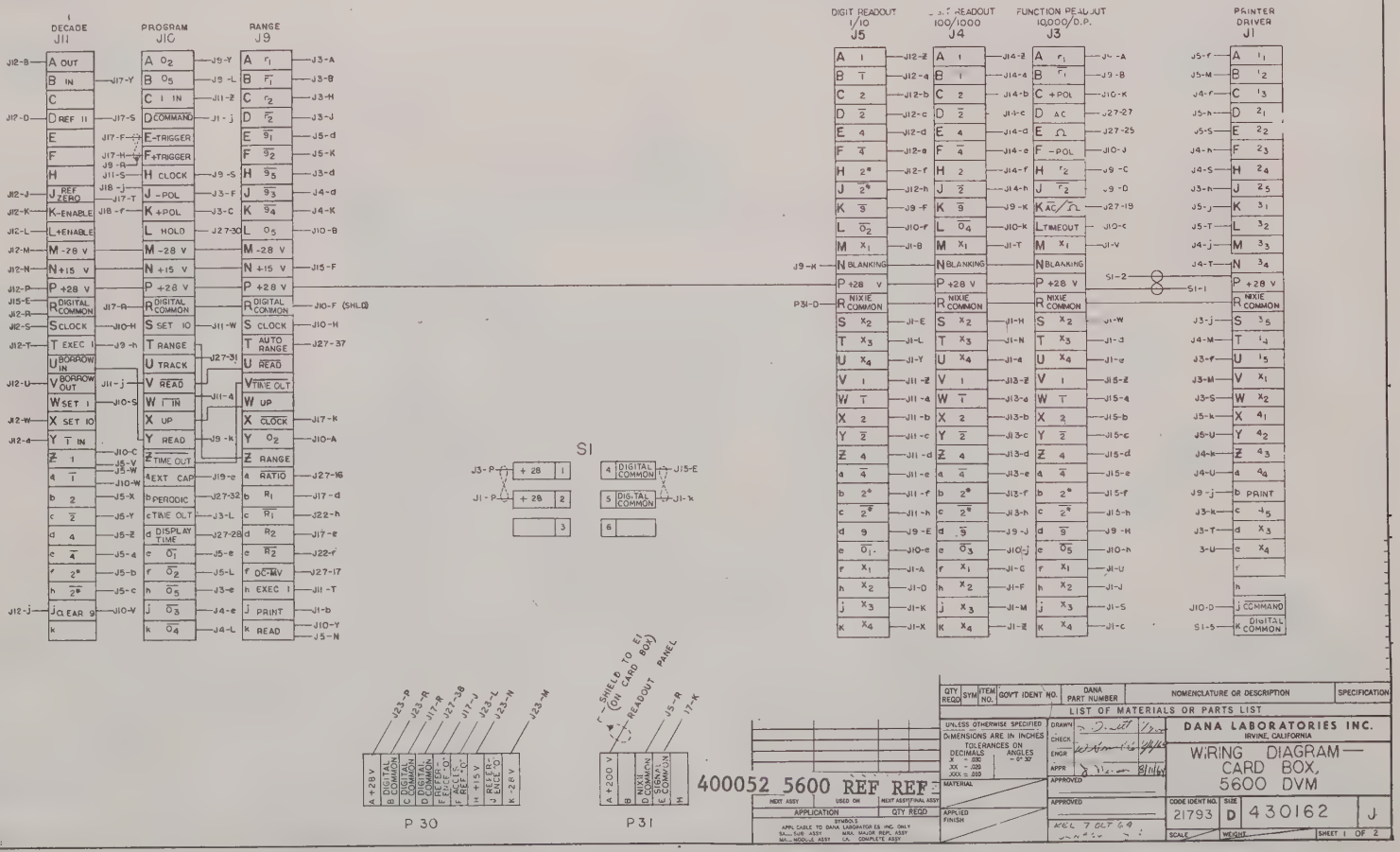
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS X ± .030, XX ± .020, XXX ± .010; ANGLES ± 0° 30'
MATERIAL
APPLIED FINISH

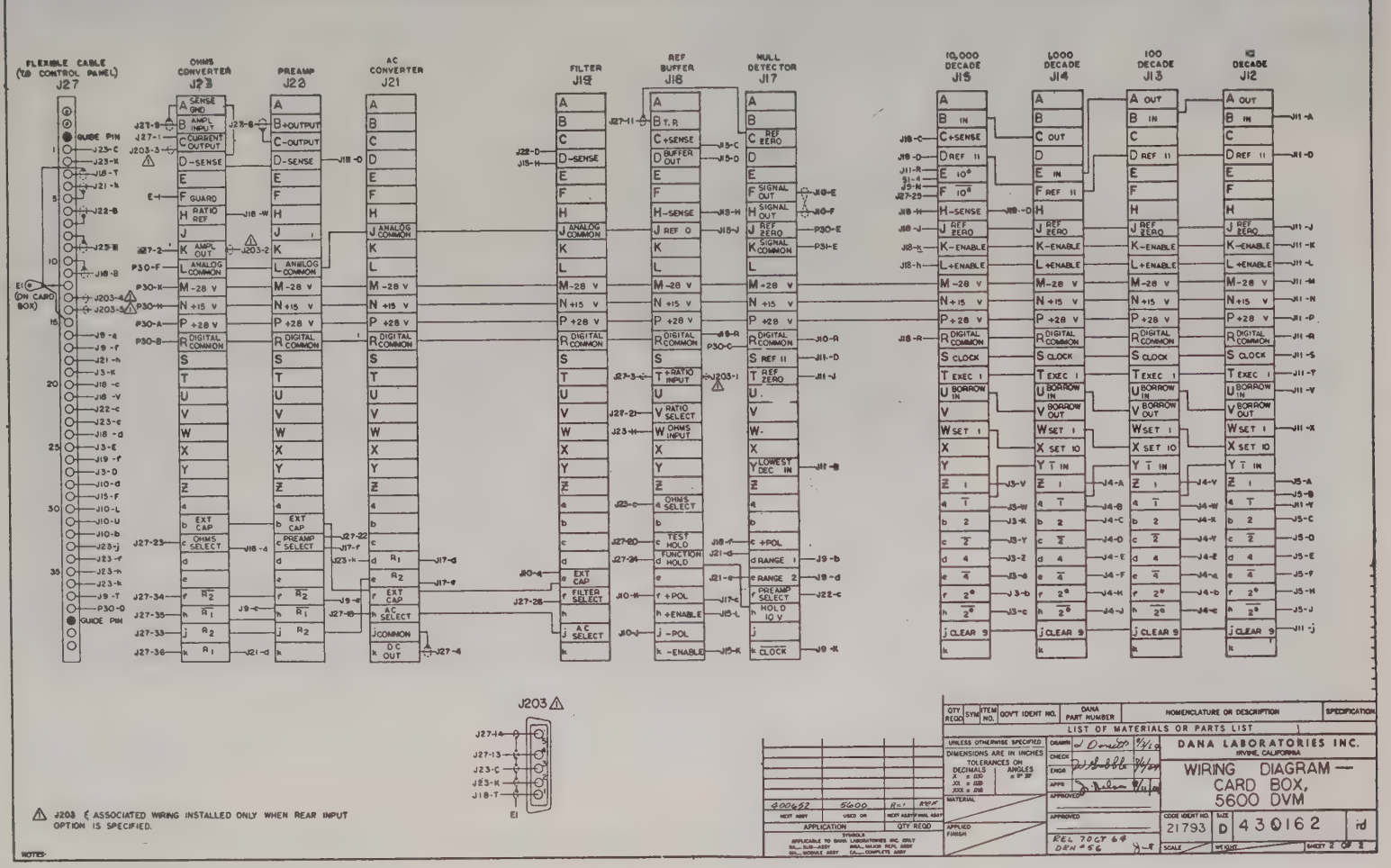
DRAWN D. Elias 9 June 1969
CHECK R. Davis 7/1/69
ENGR J. Mahan
APPROVED
APPROVED
REL 7 OCT 64 DEN 56 J.T.

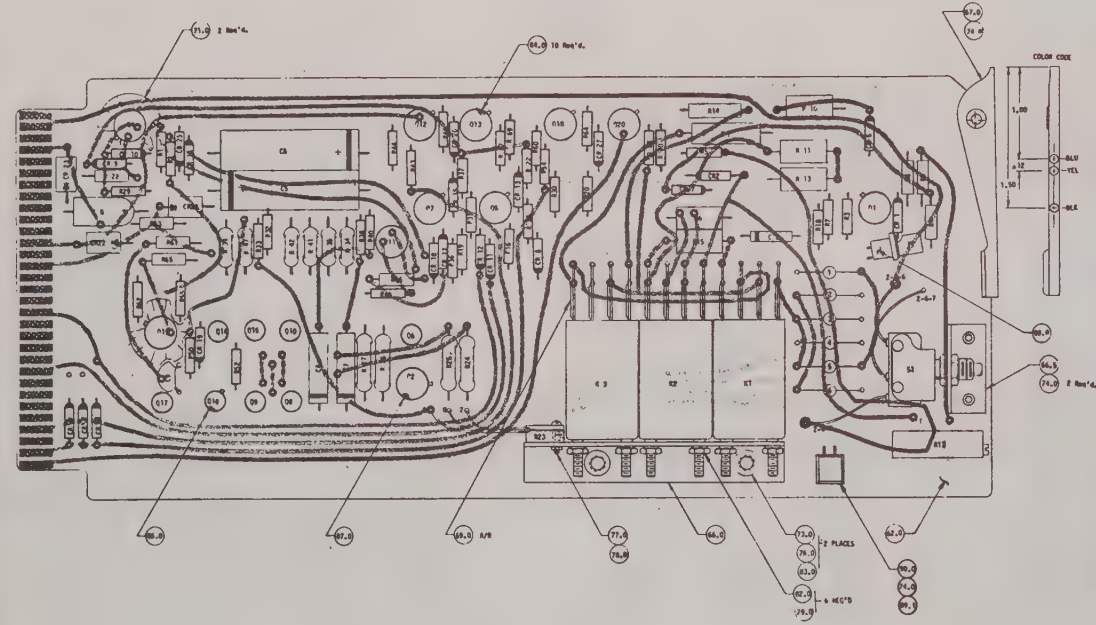
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

WIRING DIAGRAM - CONTROL PANEL 5600

CODE IDENT NO. | SIZE D | 430169 | H
SCALE | WEIGHT | SHEET 1 OF 1


DECADE J11
PROGRAM J10
RANGE J9
DIGIT READOUT 1/10 J5
READOUT 100/1000 J4
FUNCTION READOUT 10,000/O.P. J3
PRINTER DRIVER J1
A OUT
B IN
C
D REF 11
E
F
H
J REF ZERO
K -ENABLE
L +ENABLE
M -28 V
N +15 V
P +28 V
R DIGITAL COMMON
S CLOCK
T EXEC I
U BORROW IN
V BORROW OUT
W SET I
X SET 10
Y T IN
Z 1
a T
b 2
c 2
d 4
e 4
f 2*
h 2*
j CLEAR 9
k
A O2
B O5
C I IN
D COMMAND
E -TRIGGER
F +TRIGGER
H CLOCK
J -POL
K +POL
L HOLD
M -28 V
N +15 V
P +28 V
R DIGITAL COMMON
S SET 10
T RANGE
U TRACK
V READ
W T IN
X UP
Y READ
Z TIME OUT
a EXT CAP
b PERIODIC
c TIME OUT
d DISPLAY TIME
e O1
f O2
h O5
j O3
k O4
A r1
B r1
C r2
D r2
E 91
F 92
H 95
J 93
K 94
L O5
M -28 V
N +15 V
P +28 V
R DIGITAL COMMON
S CLOCK
T AUTO RANGE
U READ
V TIME OUT
W UP
X CLOCK
Y O2
Z RANGE
a RATIO
b R1
c R1
d R2
e R2
f DC-MV
h EXEC I
j PRINT
k READ
A 1
B T
C 2
D 2
E 4
F 4
H 2
J 2*
K 9
L O4
M X1
N BLANKING
P +28 V
R NIXIE COMMON
S X2
T X3
U X4
V 1
W T
X 2
Y 2
Z 4
a 4
b 2*
c 2*
d 9
e O3
f X1
h X2
j X3
k X4
A r1
B r1
C +POL
D AC
E Ω
F -POL
H r2
J r2
K AC/Ω
L TIMEOUT
M X1
N BLANKING
P +28 V
R NIXIE COMMON
S X2
T X3
U X4
V 1
W T
X 2
Y 2
Z 4
a 4
b 2*
c 2*
d 9
e O5
f X1
h X2
j X3
k X4
A 1
B 2
C 3
D 21
E 22
F 23
H 24
J 25
K 31
L 32
M 33
N 34
P +28 V
R NIXIE COMMON
S 35
T 14
U 15
V X1
W X2
X 41
Y 42
Z 43
a 44
b PRINT
c 45
d X3
e X4
f
h
J COMMAND
K DIGITAL COMMON
S1
+28
+28
DIGITAL COMMON
DIGITAL COMMON
P30
P31
A +28 V
B DIGITAL COMMON
C DIGITAL COMMON
D DIGITAL COMMON
E REFERENCE O
F REF. IC.
H +15 V
J REFERENCE O
K -28 V
A +200 V
B
D NIXIE COMMON
E SIGNAL COMMON
H
SHIELD TO E1 (ON CARD BOX)
READOUT PANEL
400052 5600 REF REF
NOTES:
QTY REQD
SYM
ITEM NO.
GOV'T IDENT NO.
DANA PART NUMBER
NOMENCLATURE OR DESCRIPTION
SPECIFICATION
LIST OF MATERIALS OR PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS X ± .030 XX ± .020 XXX ± .010 ANGLES ± 0° 30'
MATERIAL
NEXT ASSY
USED ON
NEXT ASSY/FINAL ASSY
APPLICATION
QTY REQD
APPLIED FINISH
SYMBOLS APPL CABLE TO DANA LABORATORIES INC. ONLY SA—SUB ASSY MA—MOD.-C ASSY MAJ. MAJOR REPL ASSY CA—COMPLETE ASSY
DRAWN
CHECK
ENGR
APPR
APPROVED
APPROVED
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
WIRING DIAGRAM — CARD BOX, 5600 DVM
CODE IDENT NO. 21793
SIZE D
430162
J
SCALE
WEIGHT
SHEET 1 OF 2


FLEXIBLE CABLE (TO CONTROL PANEL) J27
OHMS CONVERTER J23
PREAMP J22
AC CONVERTER J21
FILTER J19
REF BUFFER J18
NULL DETECTOR J17
10,000 DECADE J15
1,000 DECADE J14
100 DECADE J13
10 DECADE J12
GUIDE PIN
SENSE GND
AMPL INPUT
CURRENT OUTPUT
D-SENSE
GUARD
RATIO REF
AMPL OUT
ANALOG COMMON
M -28 V
N +15 V
P +28 V
DIGITAL COMMON
EXT CAP
OHMS SELECT
PREAMP SELECT
AC SELECT
COMMON
DC OUT
B+OUTPUT
C-OUTPUT
ANALOG COMMON
T.P.
+SENSE
BUFFER OUT
-SENSE
REF 0
T RATIO INPUT
V RATIO SELECT
W OHMS INPUT
OHMS SELECT
TEST HOLD
FUNCTION HOLD
+POL
+ENABLE
-POL
-ENABLE
EXT CAP
FILTER SELECT
AC SELECT
REF ZERO
SIGNAL OUT
SIGNAL COMMON
REF ZERO
DIGITAL COMMON
REF 11
LOWEST DEC IN
+RANGE
RANGE 2
PREAMP SELECT
HOLD 10 V
CLOCK
IN
OUT
+SENSE
REF 11
-SENSE
REF ZERO
+ENABLE
-ENABLE
DIGITAL COMMON
CLOCK
EXEC 1
BORROW IN
BORROW OUT
SET 1
SET 10
J203
J27-14
J27-13
J23-C
J23-K
J18-T
E1
J203 ⚠ ASSOCIATED WIRING INSTALLED ONLY WHEN REAR INPUT OPTION IS SPECIFIED.
NOTES:
QTY REQD
SYM
ITEM NO.
GOVT IDENT NO.
DANA PART NUMBER
NOMENCLATURE OR DESCRIPTION
SPECIFICATION
LIST OF MATERIALS OR PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS
ANGLES
DRAWN
CHECK
ENGR
APPR
APPROVED
MATERIAL
APPLIED FINISH
APPLICATION
QTY REQD
800652
5600
R-1
NEXT ASSY
USED ON
NEXT ASSY/FINAL ASSY
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
WIRING DIAGRAM — CARD BOX, 5600 DVM
CODE IDENT NO.
21793
SIZE
D
430162
REL 7 OCT 68
DRN 456
SCALE
WEIGHT
SHEET 2 OF 2



REF DES	BM	ITEM	DESCRIPTION
C9	41.8		.001 MFD, 35 V
C8	42.0		22 MFD, 25 V
C7	44.1		.047 MFD 100V
C6	43.0		50 MFD, 50V
C5	43.0		50 MFD, 50 V
C4	44.0		.047MFD,100V
C3	45.0		.01 MFD 100V
C2	44.5		10 MFD, 25 V

REF DES	BM	ITEM	DESCRIPTION
C9	41.8		.001 MFD, 35 V
C8	42.0		22 MFD, 25 V
C7	44.1		.047 MFD 100V
C6	43.0		50 MFD, 50V
C5	43.0		50 MFD, 50 V
C4	44.0		.047MFD,100V
C3	45.0		.01 MFD 100V
C2	44.5		10 MFD, 25 V
C19	48.8		2N3866
C18	48.8		2N3645
C17	46.7		.014
C16	48.8		2N3565
C15	46.7		.014
C14	46.7		.014
Q2	46		2N1195
Q1	50.0		009
K3	60.0		Relay
K2	60.0		Relay
K1	60.0		Relay
F1	69.1		FUSE 1/10 A
CR 27	57.0		1/4W 2.4A210
CR 26	57.0		1/4W 2.4A210
CR25	56.7		1N963B
CR24	51.5		SD 4
CR23	51.5		SD 4
CR22	51.5		SD 4
CR16	56.2		1/4 1N752A
CR7	55.0		1N751
CR6	57.0		GAT
CR2	61.0		FSV
CR1	57.0		1/4W 2.4A210
Q20	50.0		009
Q19	46.7		014
Q18	47.0		2N1304
Q17	48.8		2N3866
Q16	46.5		412
Q15	48.8		2N3865
Q14	48.8		2N3869
Q13	50.4		409
Q12	47.0		2N1304
Q11	50.0		009
Q10	48.8		2N3865

REF DES	BM	ITEM	DESCRIPTION
R30	37.0		6.8K
R29	9.0		22k
R28	24.0		39 Ohm 1/2W
R27	32.0		100 Ohm 1%
R26	32.0		100 Ohm 1%
R25	27.0		60.4K 1%
R24	27.0		60.4K 1%
R23	33.0		10K Pot
R22	5.0		120K
R21	6.0		15K
R20	17.0		6.8K
R19	2.0		120 Ohm
R18	13.0		5.1K
R17	40.0		20K Pot
R16	2.0		120 Ohm
R15	34.0		11K .01%5PPM
R14	26.5		301K 1%
R13	36.5		1.21K .1%
R11	61.0		FSV
R10	61.0		FSV
R9	22.0		680 Ohm 1/2w
R8	22.0		680 Ohm 1/2%
R7	18.0		75 Ohm
R6	36.0		9K .01% 5PPM
R5	16.0		680 Ohm
R4	20.0		5.11K 1/2%
R3	6.0		15K
R2	1.0		10 Ohm
R1	1.0		10 Ohm

REF DES	BM	ITEM	DESCRIPTION
S1	72.0		P/N 600094
R70	12.5		3.3 K
R69	12.5		3.3 K
R 68	10.5		39 ohm
R 67	10.5		39 ohm
R65	19.3		2.2K 1/2W
R64	3.0		1.2K
R62	3.0		1.2K
R61	21.0		5.6K 1/2W
R60	1.2		10K
R55	19.0		7.5K
R54	14.9		5.6K
R53	21.0		5.6K 1/2W
R52	10.8		240 Ohm
R50	9.0		22K
R49	3.0		1.2K
R47	24.6	7.5 K	1% MH600
R46	9.0		22K
R45	23.0		47 Ohm 1/2W
R44	1.2		10K
R43	14.9		5.6K
R42	24.2	2.43 K	1% RN60D
R41	24.4	20 K	1% RN60D
R40	4.0		12K
R39	24.6	7.5 K	1% MH600
R38	4.0		12K
R37	5.0		120K
R36	2.0		120 ohm
R35	24.2	2.43 K	1% RN60D
R34	26.7	40.2 K	1% RN60D
R33	16.0		51K
R32	13.0		5.1K
R31	1.0		1K

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
400499		1408				
400420		1401	1			
400370		1400	1			
NEXT ASSY		USED ON	NEXT ASSY	FINAL ASSY		

LIST OF MATERIALS OR PARTS LIST

APPLICATION — QTY REQD

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA.- SUB ASSY MFR.- MAJOR REPL ASSY
MA.- MODULE ASSY CA.- COMPLETE ASSY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: X ± .030, XX ± .020, XXX ± .010
ANGLES ± 0° 30'

MATERIAL

APPLIED FINISH

DRAWN
CHECK
ERGR
APPR
APPROVED
APPROVED

DANA LABORATORIES, INC.
IRVINE, CALIFORNIA

PC BOARD ASSY
INTERNAL REFERENCES
BUFFER

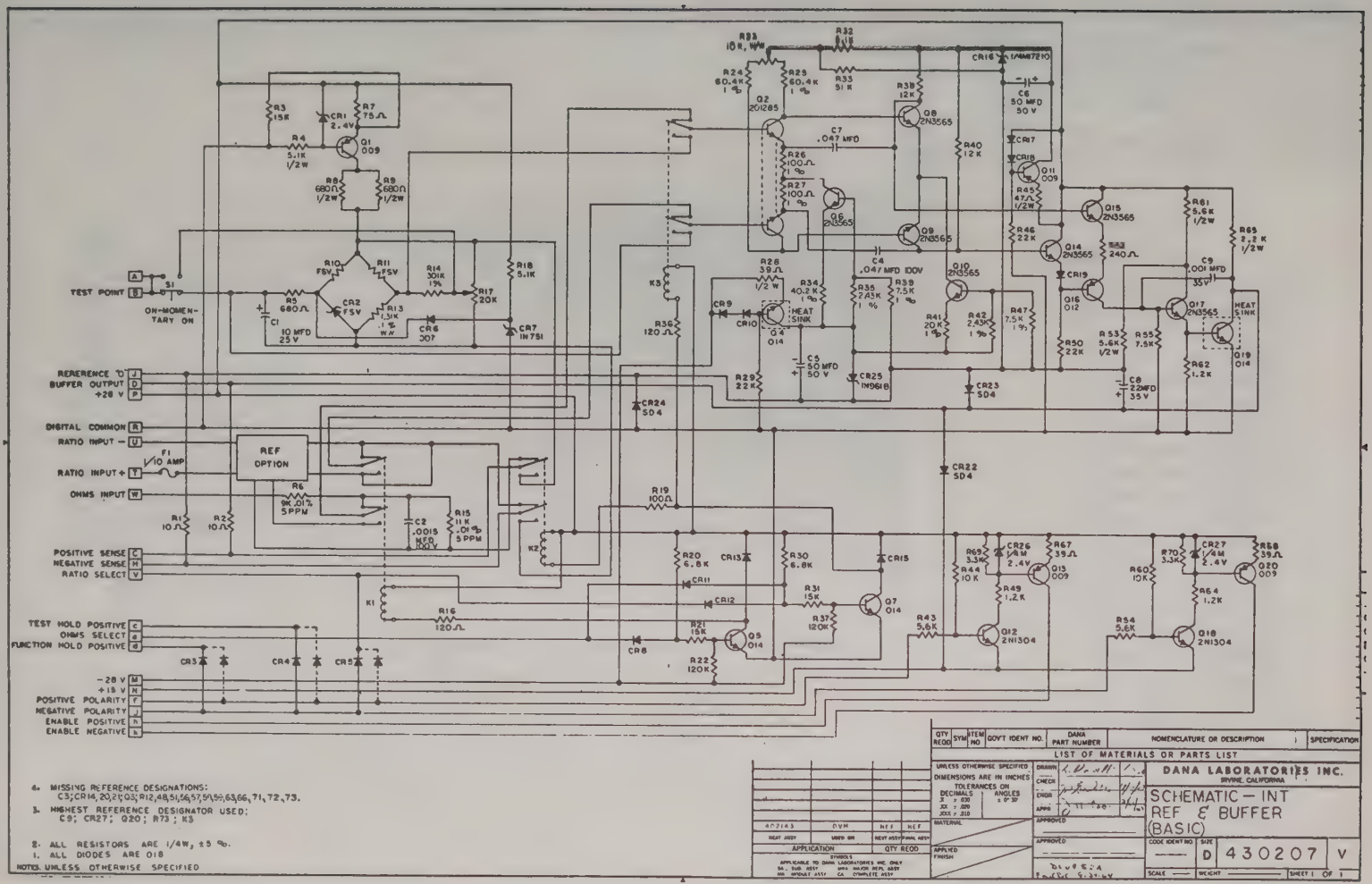
CODE IDENT NO. | SIZE | 400370 | W

SCALE | WEIGHT | SHEET

NOTES
3. ALL RESISTORS, 1% TOLERANCE EXCEPT ARE ± .01%.
2. ALL RESISTORS ARE 1/4W, ± 5 %, CARBON
1. ALL WIRES ARE 24 GA TEFLON

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED



4. MISSING REFERENCE DESIGNATIONS:
C3; CR14, 20, 21, 23; R12, 48, 51, 56, 57, 59, 62, 63, 66, 71, 72, 73.
3. HIGHEST REFERENCE DESIGNATOR USED:
C9; CR27; Q20; R73; K3
2. ALL RESISTORS ARE 1/4W, ±5 %.
1. ALL DIODES ARE D18
NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	SYM	ITEM NO	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
LIST OF MATERIALS OR PARTS LIST						

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: X ± .020, XX ± .010, XXX ± .010
ANGLES ± 0° 30'

DRAWN K. Brandt 7-1-64
CHECK
ENGR
APPR

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC — INT REF & BUFFER (BASIC)

CODE IDENT NO. —— SIZE D 430207 V

SCALE —— WEIGHT —— SHEET 1 OF 1

4/7/143	DVM	REF	REF
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY

APPLICATION — QTY REQD

MATERIAL

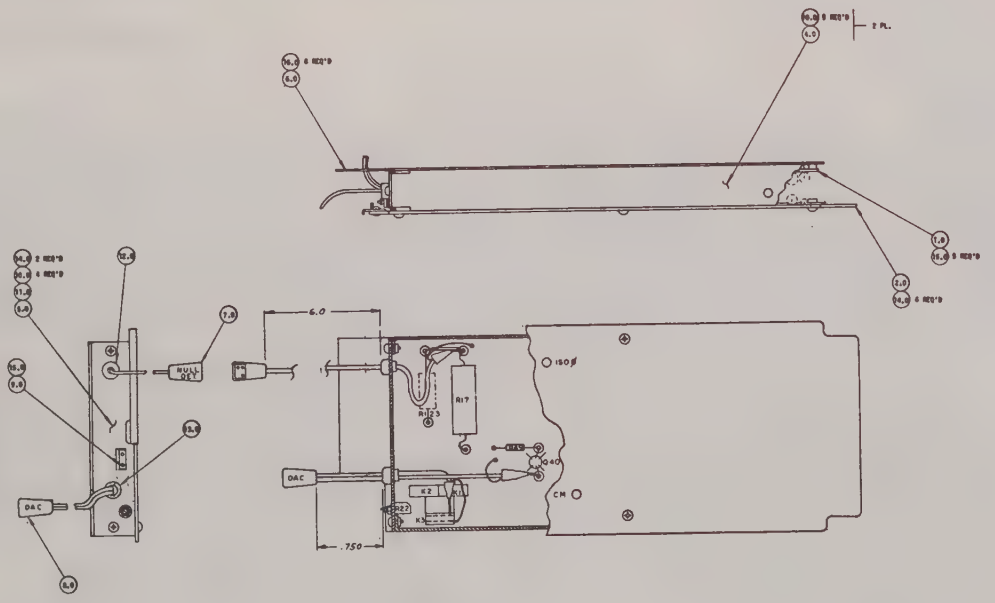
APPLIED FINISH

APPROVED

APPROVED

Drwg E-2-A
Tr/Vc 5-27-64

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA. SUB. ASSY — MA. MAJOR REPL. ASSY
MI. MINOR ASSY — CA. COMPLETE ASSY



CROSS REFERENCE CHART

Item No.	Part No.
1.0	400438
2.0	400439
4.0	450287
5.0	450288
6.0	450329
7.0	450386
8.0	450387
9.0	600081
10.0	610111
11.0	610141
12.0	610143
13.0	610144
14.0	615042
15.0	615513
16.0	615541

1 SCHEMATIC REFERENCE P/N 430255

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	SYM	ITEM NO.	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS: .X ± .030, .XX ± .020, .XXX ± .010; ANGLES ± 0° 30'
FORMED ANGLES ± 1°
ECCENTRICITY BETWEEN DIA ON THE SAME AXIS SHALL NOT EXCEED .010 TIR
INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL D 1000 AND MIL D 70327

CONTRACT NO.

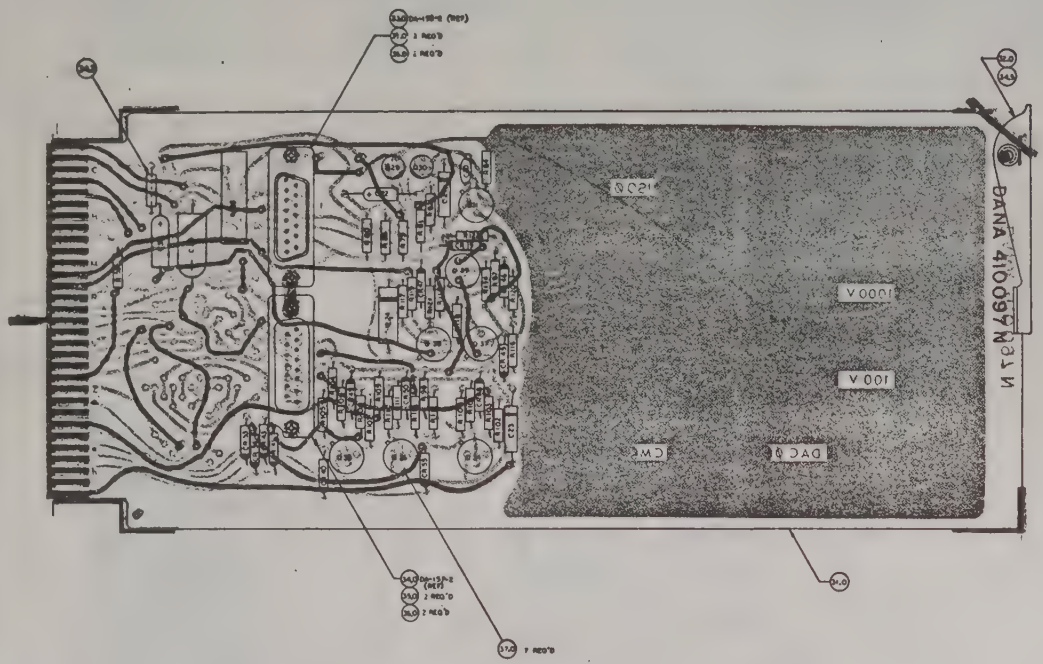
NAME	DATE
DR	
CHK	
APPD	

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

NULL DETECTOR ASSY-
5600 SERIES

SIZE	CODE IDENT NO	DWG NO.
D		400461 T

SCALE 1/1 | WT | SHEET 1 OF 1



CROSS REFERENCE CHART

Item No.	Part No.
31.0	410097N
32.0	451036
34.2	600245
33.0	600063
34.0	600069
34.5	610019
35.0	610093
36.0	615014
37.0	920006

QTY REQD	SYM	ITEM NO.	GOV'T IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	
402273		5643	/	/		
402273		5603	/	/		
402273		5640	/	/		
402273		5600	/	/		

NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY

APPLICATION | QTY REQD

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS .X ± .020, .XX ± .010, .XXX ± .005; ANGLES ± 0° 30'

MATERIAL

APPLIED FINISH

DRAWN X. Hassan 8/1/68
CHECK
ENGR
APPR
APPROVED
APPROVED
DATE 1-27-66

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P C BOARD ASS'Y
NULL DETECTOR MAIN
5 DIGIT 5600

CODE IDENT NO. | SIZE D | 400439 | R

SCALE 2:1 | WEIGHT | SHEET

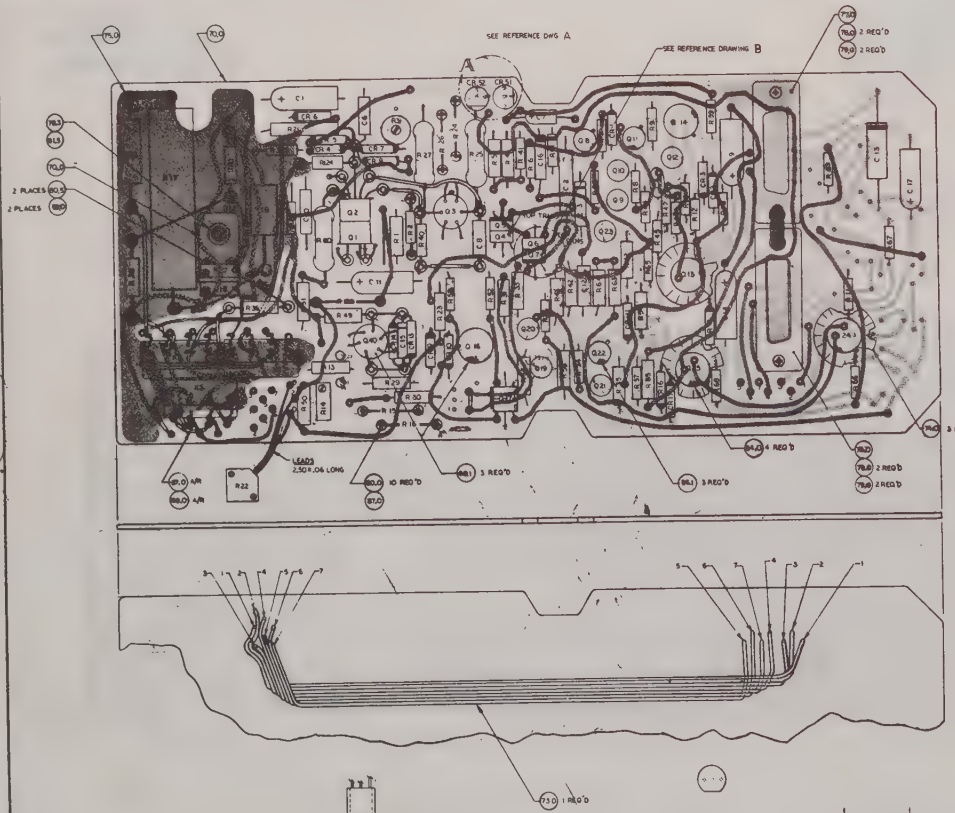
4. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

5. AFTER CARD IDENTIFICATION LABEL 920720 (ITEM 37, -400707) IS APPLIED IN LOCATION SHOWN, BOARDS FINAL ASSEMBLY OF DASH.

2. ALL DIODES ARE 1N48

1. ALL RESISTORS TO BE 1/4W ±5%

NOTES: UNLESS OTHERWISE SPECIFIED



CROSS REFERENCE CHART

Item No.	Part No.
70.0	410096K
72.0	450530C
72.2	500004
73.0	500019
73.5	501376
74.0	600016
75.0	600030
76.0	600063
77.0	600069
78.0	610093
78.3	610111
79.0	610141
80.0	610145
81.0	615014
83.0	617001
84.0	920006
85.1	920007
86.1	920082
85.2	920008
81.5	615041

QTY REQD | SYM | ITEM NO. | GOV'T IDENT NO. | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | SPECIFICATION

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS X ± .030 XX ± .020 .XXX ± .010
ANGLES ± 0° 30'

MATERIAL
APPLIED FINISH
NEXT ASSY | USED ON | NEXT ASSY/FINAL ASSY
APPLICATION | QTY REQD

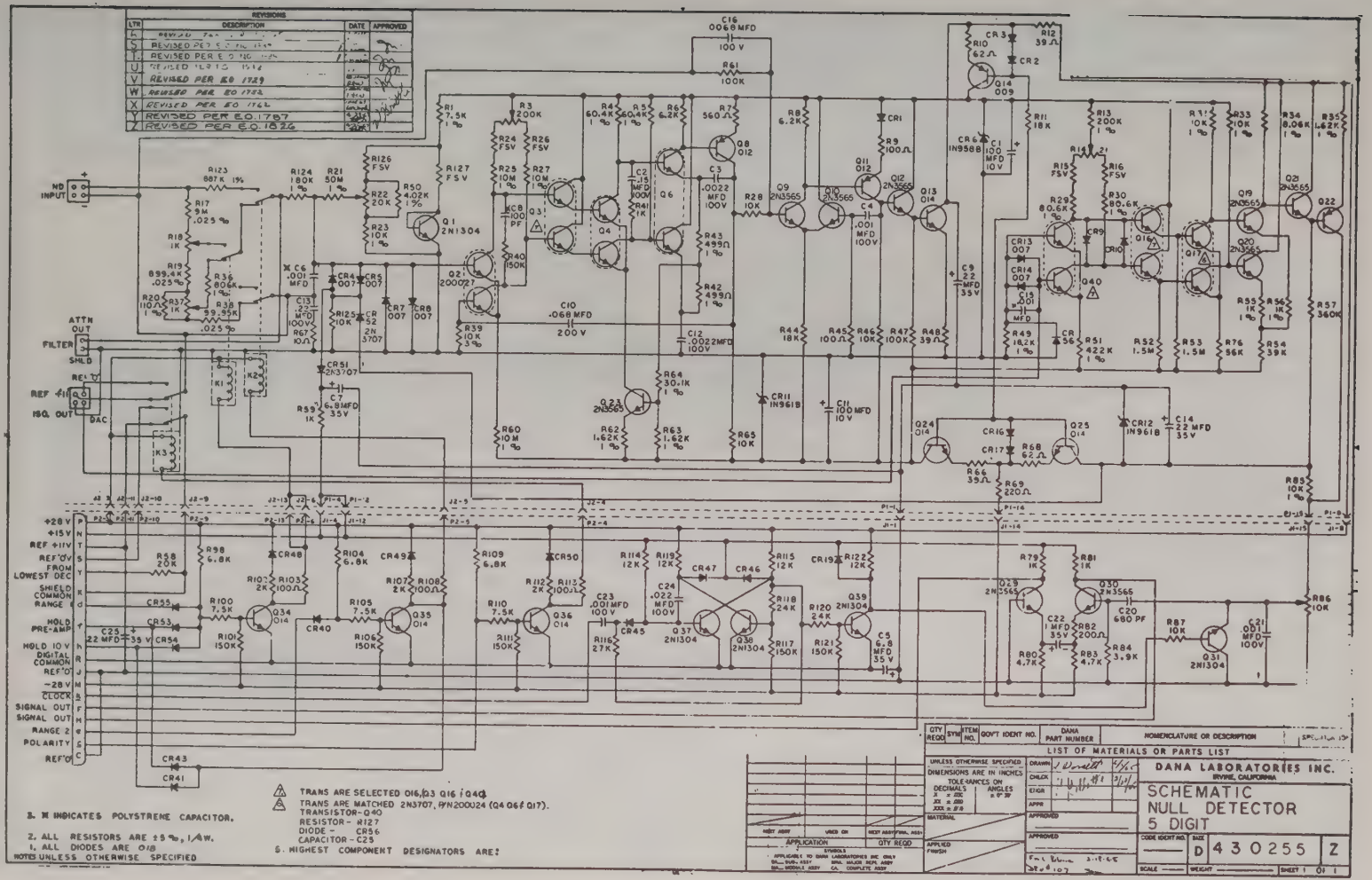
SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA—SUB-ASSY MRA—MAJOR REPL. ASSY
MA—MODULE ASSY CA—COMPLETE ASSY

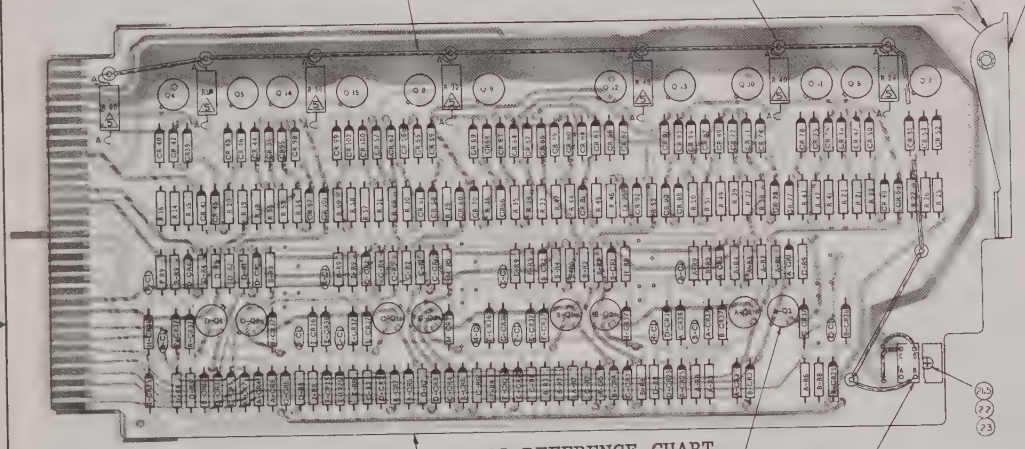
DRAWN | CHECK | ENGR | APPR | APPROVED | APPROVED | D.R. 8-4-66

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C BOARD ASSY
NULL DETECTOR ISOLATOR
5 DIGIT

CODE IDENT NO. | SIZE D | 400438 | T
SCALE 2/1 | WEIGHT | SHEET 4 OF C


REVISIONS
LTR DESCRIPTION DATE APPROVED
S REVISED PER E.O. 1819
U REVISED PER E.O. 1914
V REVISED PER E.O. 1929
W REVISED PER E.O. 1782
X REVISED PER E.O. 1762
Y REVISED PER E.O. 1787
Z REVISED PER E.O. 1826
ND INPUT
ATTN OUT
FILTER
SHLD
REF 0
REF +11V
SQ. OUT
DAC
+28 V
+15 V
REF +11V
REF 0V FROM LOWEST DEC
SHIELD COMMON RANGE
HOLD PRE-AMP
HOLD 10 V DIGITAL COMMON
REF 10
-28 V
CLOCK
SIGNAL OUT
SIGNAL OUT
RANGE 2
POLARITY
REF 0
1. X INDICATES POLYSTRENE CAPACITOR.
2. ALL RESISTORS ARE ±5%, 1/4W.
3. ALL DIODES ARE 1N
NOTES UNLESS OTHERWISE SPECIFIED
TRANS ARE SELECTED Q16, Q3 Q16 / Q4 Q.
TRANS ARE MATCHED 2N3707, H/N200Z4 (Q4 Q6 / Q17).
TRANSISTOR - Q40
RESISTOR - R127
DIODE - CR56
CAPACITOR - C25
5. HIGHEST COMPONENT DESIGNATORS ARE:
QTY REQD ITEM NO. GOV'T IDENT NO. DANA PART NUMBER NOMENCLATURE OR DESCRIPTION
LIST OF MATERIALS OR PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS
ANGLES
DRAWN
CHECK
ENGR
APPR
APPROVED
MATERIAL
APPLIED FINISH
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC
NULL DETECTOR
5 DIGIT
CODE IDENT NO.
SIZE
D 430255 Z
SCALE
WEIGHT
SHEET 1 OF 1



SEE DETAIL A

20 9 REQ'D

24 20 REQ'D

REF DES	B/M ITEM	DESCRIPTION
R 7	3	24 K
R 6	2	50 K
R 5	3	24 K
R 4	1	12 K
R 3	2	150 K
R 2	3	24 K
R 1	1	12 K
C 1	8	330 pf
Q 5	8,7	2N1308 (SELECTED)
THRU		THRU
Q 4	8,7	2N1308 (SELECTED)
Q 2	9	2N1304
Q 1	9	2N1304
CR102	11	1N662
THRU		THRU
CR 39	11	1N662
CR 37	11	1N662
CR 36		1N662
CR 25	11	1N662
CR 8	11	1N662
THRU		THRU
CR 1	11	1N662

REF DES	B/M ITEM	DESCRIPTION
R 41	5	300 K
R 40	7	10 K 01%
R 39	5	300 K
R 38	3	24 K
R 37	3	24 K
R 36	6	39 K
R 35	6	39 K
R 34	6	39 K
R 33	5	300 K
R 31	7	100 K 01%
R 3	5	300 K
R 30	3	24 K
R 29	3	24 K
R 28	3	24 K
R 27	6	39 K
R 26	6	39 K
R 25	5	300 K
R 24	7	100 K 01%
R 23	5	300 K
R 22	3	24 K
R 21	3	24 K
R 20	6	39 K
R 19	6	39 K
R 18	5	300 K
R 17	7	200.002ohms .01%
R 16	5	300 K
R 15	3	24 K
R 14	3	24 K
R 9	4	27 K
R 8	2	150 K

REF DES	B/M ITEM	DESCRIPTION
R 60	7	180.002ohms .01%
R 59	6	39 K
R 58	6	39 K
R 57	5	300 K
R 56	7	200.002ohm .01%
R 55	5	300 K
R 54	3	24 K
R 53	3	24 K
R 52	6	39 K
R 51	6	39 K
R 50	6	39 K
R 49	5	300 K
R 48	7	.00 K .01%
R 47	5	300 K
R 46	3	24 K
R 45	3	24 K
R 44	3	24 K
R 43	6	39 K
R 42	6	39K

CROSS REFERENCE CHART

Item No.	Part No.
12	-------410129J
15	-------451036
16	-------500004
17	-------501376
18	-------600083
19	-------610019
17.5	-------600030
21.5	-------615265
22	-------617014
23	-------617075
24	-------920006

DETAIL A

400349	5600	1	1
400395	5640	1	1
400420	5603	1	1
400308	5600	1	1

NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY

APPLICATION | QTY REQD

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA—SUB-ASSY MRA—MAJOR REPL ASSY
MA—MODULE ASSY CA—COMPLETE ASSY

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS X ± .030 XX ± .020 XXX ± .010
ANGLES ± 0° 30'

MATERIAL SEE ./M

FINISH

DRAWN	W Lee	1-31-66
CHECK	[illegible]	2-1-66
ENGR	[illegible]	2-1-66
APPR	[illegible]	2-1-66
APPROVED		
APPROVED	[illegible]	2-1-66

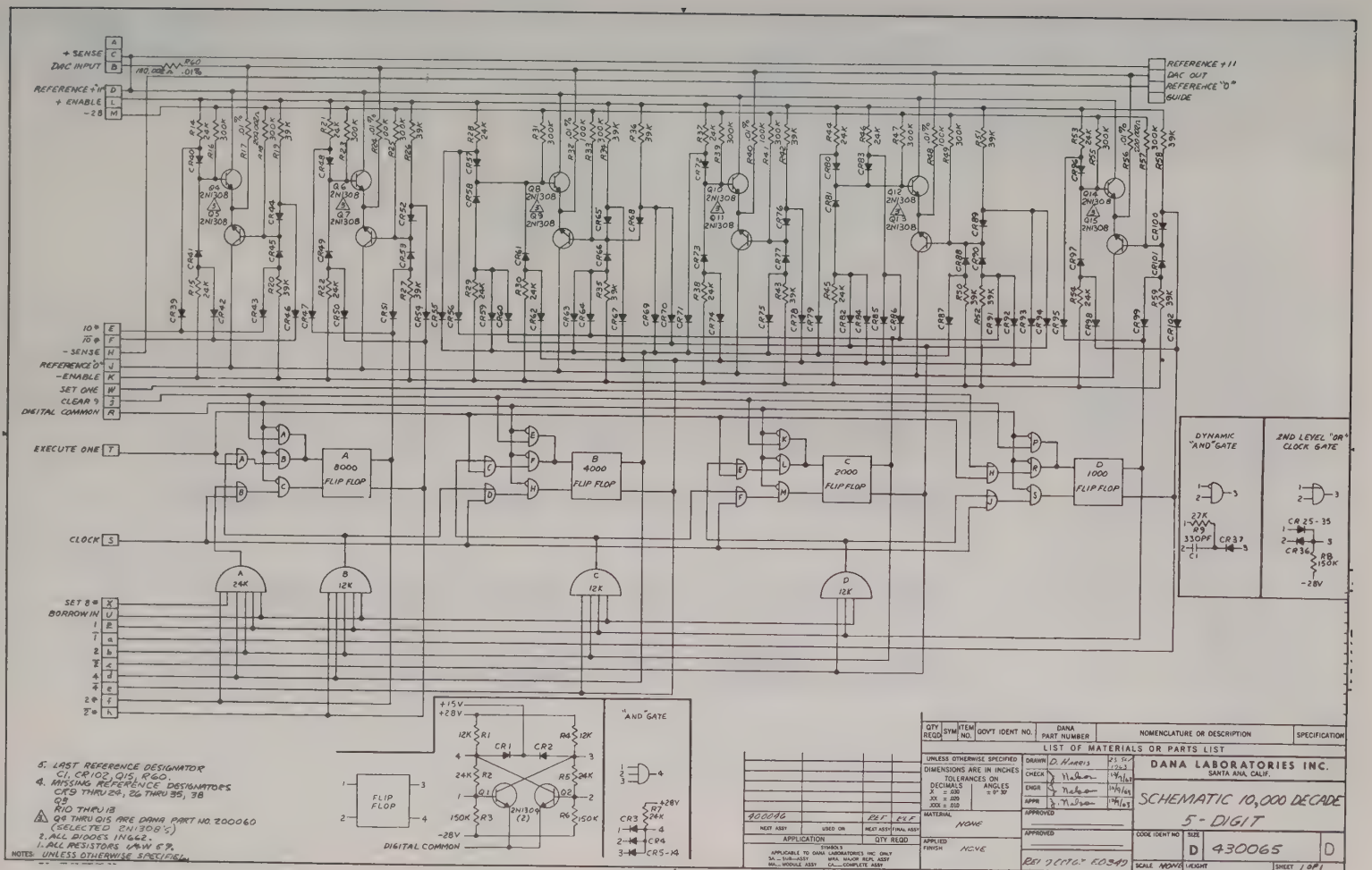
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C. BOARD ASS'Y-
10,000 DECADE
5 DIGIT 5600

CODE IDENT NO. —— | SIZE D | 400258 | R

SCALE 2/1 | WEIGHT —— | SHEET 1 OF 1

7. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.
8. ALL LEADS MARKED 'A' INSTALL SERVICE LOOP PER DANA WORKMANSHIP STD 8-5.
⚠ HEATSINK RESISTOR LEADS (R17,R56,R32, R40,R48,R24, & R00) WHEN SOLDERING.
⚠ AFFIX CARD IDENTIFICATION LABEL 820184 (PART OF 400787) TO HANDLE IN LOCATION SHOWN DURING FINAL ASSEMBLY OF DVM
⚠ Resistors indicated are part of the selected set (P/N 020025 B)
⚠ All Diodes are 1N662
1. ALL RESISTORS ARE 1/4 W, ± 5%, CARBON.
NOTES UNLESS OTHERWISE SPECIFIED.



5. LAST REFERENCE DESIGNATOR C1, CR102, Q15, R60
4. MISSING REFERENCE DESIGNATORS CR9 THRU 24, 26 THRU 35, 38 Q9 R10 THRU 13
3. Q9 THRU Q15 ARE DANA PART NO. 200060 (SELECTED 2N3085'S)
2. ALL DIODES 1N662.
1. ALL RESISTORS 1/4W ±5%.

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS .X = ±.100 .XX = ±.010 .XXX = ±.010 ANGLES ± 0° 30'
MATERIAL NONE
APPLIED FINISH NONE

DRAWN D. Harris 2/5/62
CHECK J. Nelson 2/9/62
ENGR J. Nelson 2/9/62
APPR J. Nelson 2/9/62
APPROVED
APPROVED

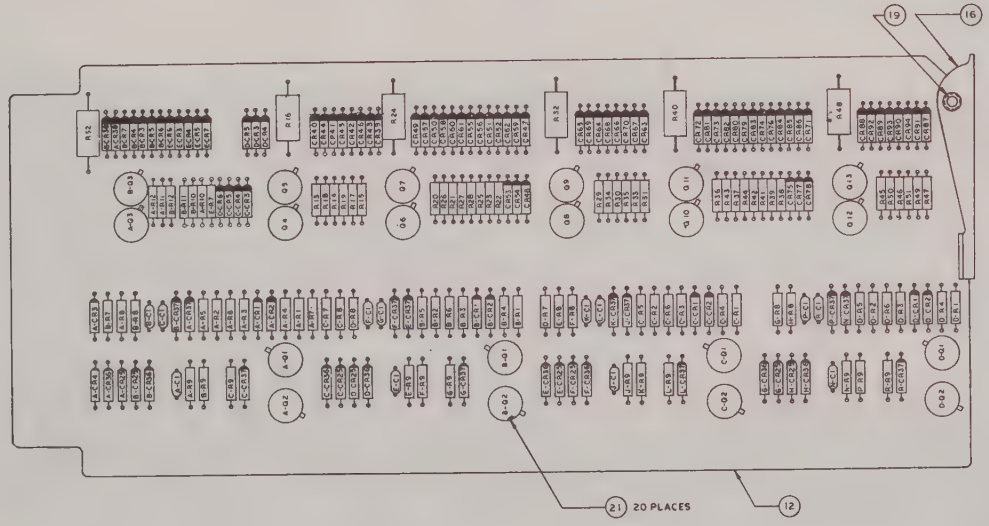
DANA LABORATORIES INC.
SANTA ANA, CALIF.

SCHEMATIC 10,000 DECADE 5-DIGIT

CODE IDENT NO 07349 | SIZE D | 430065 | D
SCALE NONE | WEIGHT | SHEET 1 OF 1

200060		REF. SYM.
NEXT ASSY	USED ON	NEXT ASSY FINAL ASSY
APPLICATION		QTY REQD

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC ONLY
SA — SUB-ASSY MA — MODULE ASSY
MRA MAJOR REPL ASSY CA — COMPLETE ASSY



REF DES	ITEM	VALUE
C-A7	3	24K
A-A7	3	24K
R35	6	39K
R34	6	39K
R33	5	300K
R32	7	100K ±.01%
R31	5	300K
R30	3	24K
R29	3	24K
R28	6	39K
R27	6	39K
R26	6	39K
R25	5	300K
R24	7	100K ±.01%
R23	5	300K
R22	3	24K
R21	3	24K
R20	3	24K
R19	6	39K
R18	6	39K
R17	5	300K
R16	7	100K ±.01%
R15	5	300K
R14	3	24K
R13	3	24K
R12	2	150K
R11	3	24K
R10	1	12K
R9	4	27K
R8	2	150K
R7	1	12K
R6	2	150K
R5	3	24K
R4	1	12K
R3	2	150K
R2	3	24K
R1	1	12K

REF DES	ITEM	VALUE
CR84	11	018
CR37		
CR36		
CR25		
CR7		
CR1	11	018
Q13	8-5	2N1308 SEL
Q4	8-5	2N1308 SEL
Q3	9	2N1304 SEL
Q2	9	2N1304 SEL
Q1	9	2N1304 SEL
C1	8	330 PF
R53	3	24K
R52	7	180K, TOL 2%
R51	6	39K
R50	6	39K
R49	5	300K
R48	7	200K, ±1%
R47	5	300K
R46	3	24K
R45	3	24K
R44	6	39K
R43	6	39K
R42	6	39K
R41	5	300K
R40	7	100K ±.01%
R39	5	300K
R38	5	24K
R37	3	24K
R36	3	24K

CROSS REFERENCE CHART	
ITEM NO.	PART NO.
12	410009 /10
14	651634
19	610019
21	509006

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
1		1		400934	5600-10	
1		1		400933	5603	
1		1		400932	5640	
1		1		400931	5600	

NEXT ASSY | USED ON | NEXT ASSY/FINAL ASSY

APPLICATION | QTY REQD

SYMBOLS: APPLICABLE TO DANA LABORATORIES INC. ONLY
SA—SUB-ASSY MRA—MAJOR REPL ASSY
MA—MODULE ASSY CA—COMPLETE ASSY

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: X ± .020, XX ± .010, XXX ± .005
ANGLES ± 0° 30'

MATERIAL: SEE L/M

FINISH

DRAWN: J.E. Sellers 6-8-65
CHECK: Jack Sellers 6-8-65
ENGR:
APPR:
APPROVED
APPROVED
DL 7-19-65
DEN 6-14

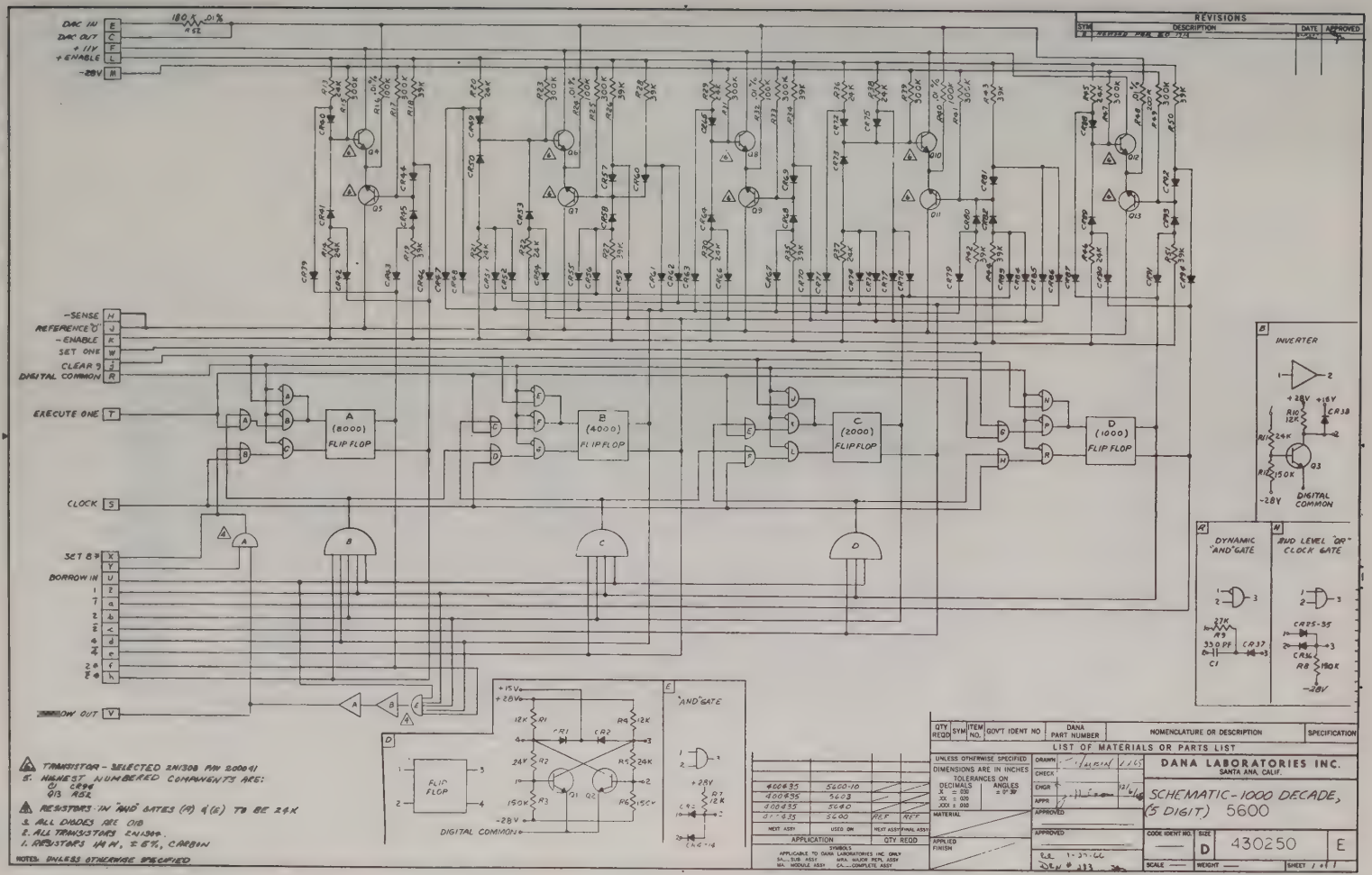
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

BOARD ASSEMBLY,
1000 DECADE
(5 DIGIT) 5600

CODE IDENT NO. | SIZE D | 400435 | REV N
SCALE 2/1 | WEIGHT | SHEET 3 OF 3

4. SCHEMATIC REFERENCE: 438298
3. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.
2. APPLY CARD IDENTIFICATION LABEL, 800118 (PART OF 400732) TO HANDLE IN LOCATION SHOWN, DURING FINAL ASSEMBLY OF DWG.
1. ALL RESISTORS ARE 1/8 W, ± 5%, CARBON.

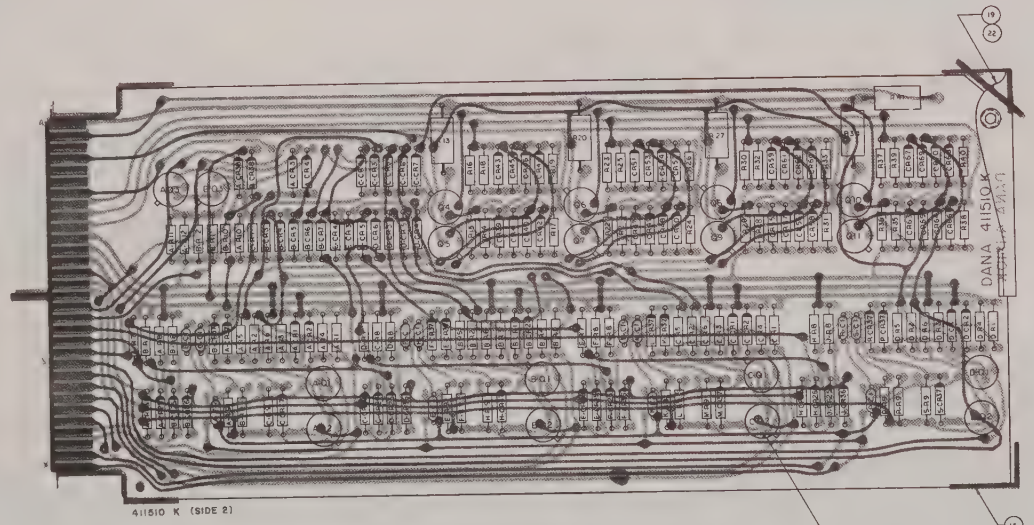
NOTES: UNLESS OTHERWISE SPECIFIED



LIST OF MATERIALS OR PARTS LIST

QTY REQD	SYM	ITEM NO.	GOV'T IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
400635				5600-10		
400635				5603		
400635				5640		
400635				5600	REF.	RITE
NEXT ASSY			USED ON		NEXT ASSY/FINAL ASSY	
APPLICATION					QTY REQD	

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA—SUB ASSY MPA—MAJOR PERF. ASSY
MA—MODULE ASSY CA—COMPLETE ASSY



REF DES	ITEM	VALUE
R28	9	300K
R27	9	100K ±1%
R26	6	39K
R25	3	24K
R24	3	24K
R23	6	39K
R22	5	300K
R21	5	300K
R20	8	50K ±.05%
R 9	7	68K
R18	6	39K
R17	6	39K
R 6	7	68K
R15	5	300K
R14	5	300K
R13	9	100K ±1%
R12	2	150K
R11	3	24K
R10	1	12K
R 9	4	27K
R 8	2	150K
R 7	3	24K, SEE NOTE 2
R 6	2	150K
R 5	3	24K
R 4	1	12K
R 3	2	150K
R 2	3	24K
R 1	1	12K

REF DES	ITEM	VALUE
Q11	13	2N1304
Q1	13	2N1304
CR70	14	IN662
CR1	14	IN662
C1	12	330 PF
A41	10	180K ±1%
R40	7	68K
R39	6	39K
R38	6	39K
R37	7	68K
R36	5	300K
R35	5	300K
R34	11	200K ±1%
R33	7	68K
R32	6	39K
R31	6	39K
R30	7	68K
R29	5	300K

PARTS REFERENCE CHART	
ITEM NO	PART NO.
15	411510
19	451036
22	610019
23	330006

4. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

3. APPLY CARD IDENTIFICATION LABEL, 920706 (PART OF 450787) TO HANDLE IN LOCATION SHOWN, REMOVE FROM ASSEMBLY OF DWG.

2. C-R7 IS 12K, ITEM 1 IN B/M

1. ALL RESISTORS ARE 1/4 W, ± 5%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED

NEXT ASSY	USED ON	NEXT ASSY/FINAL ASSY
APPLICATION		QTY REQD

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA.—SUB-ASSY MA.—MAJOR REPL. ASSY
MA.—MODULE ASSY CA.—COMPLETE ASSY

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS: X ± .030, XX ± .020, XXX ± .010
TOLERANCES ON ANGLES: ± 0° 30'

MATERIAL

APPLIED FINISH

DRAWN	W. Sterling	12/28/65
CHECK	W. Frank	12-29-65
ENGR	J. Nilsa	12/4/65
APPR		

APPROVED

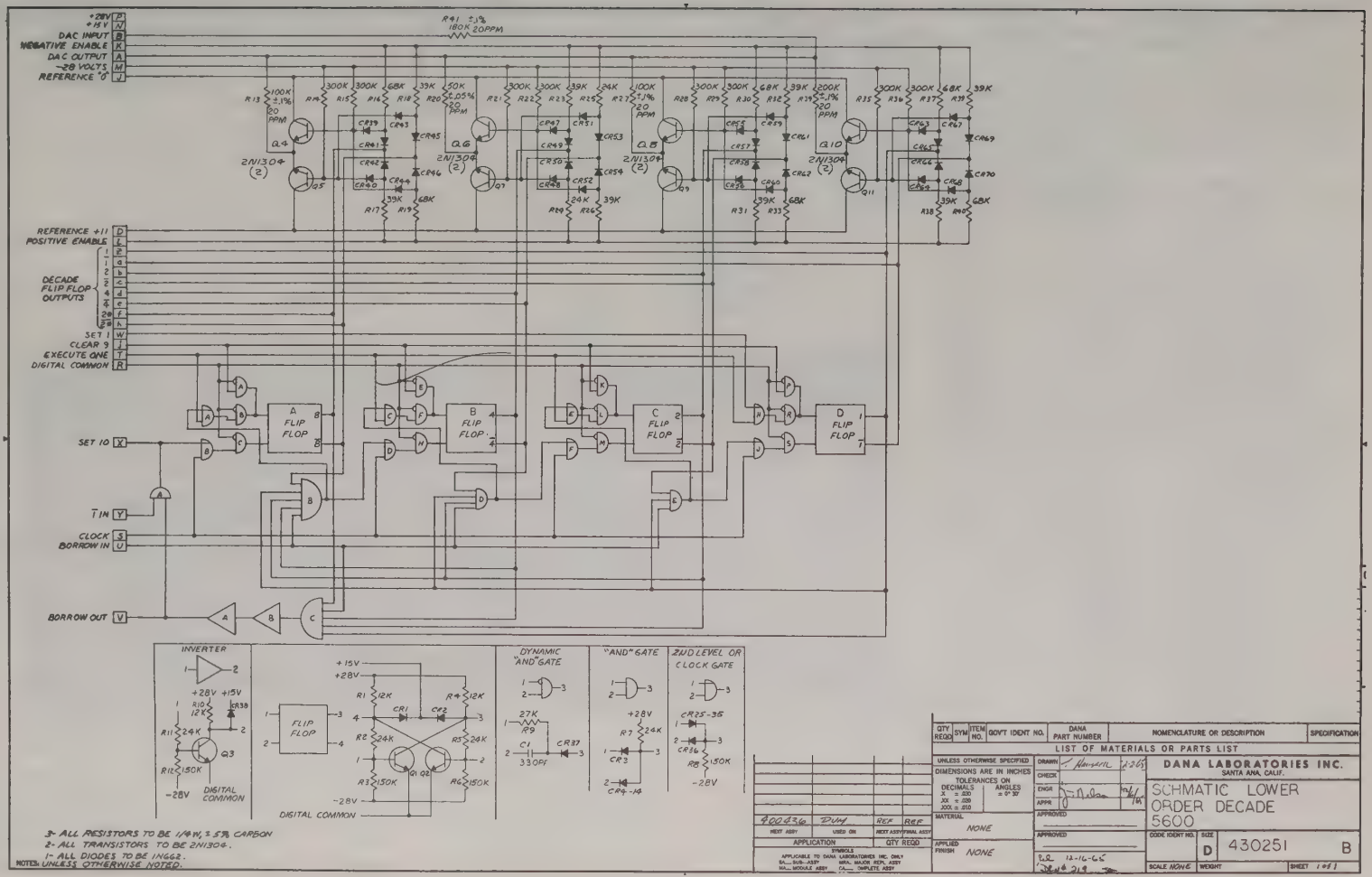
APPROVED

12-14-65
DD-6219

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

BOARD ASSEMBLY, LOWER ORDER DECADE 5600

CODE IDENT NO.	SIZE	400436	
	D		J
SCALE 2/1	WEIGHT		SHEET



3- ALL RESISTORS TO BE 1/4W, ± 5% CARBON
2- ALL TRANSISTORS TO BE 2N1304.
1- ALL DIODES TO BE 1N662.
NOTES: UNLESS OTHERWISE NOTED.

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS X ± .020, .XX ± .010, .XXX ± .010; ANGLES ± 0° 30'

MATERIAL: NONE

APPLIED FINISH: NONE

DRAWN		
CHECK		
ENGR		
APPR		
APPROVED		
APPROVED		

DANA LABORATORIES INC.
SANTA ANA, CALIF.

SCHMATIC LOWER
ORDER DECADE
5600

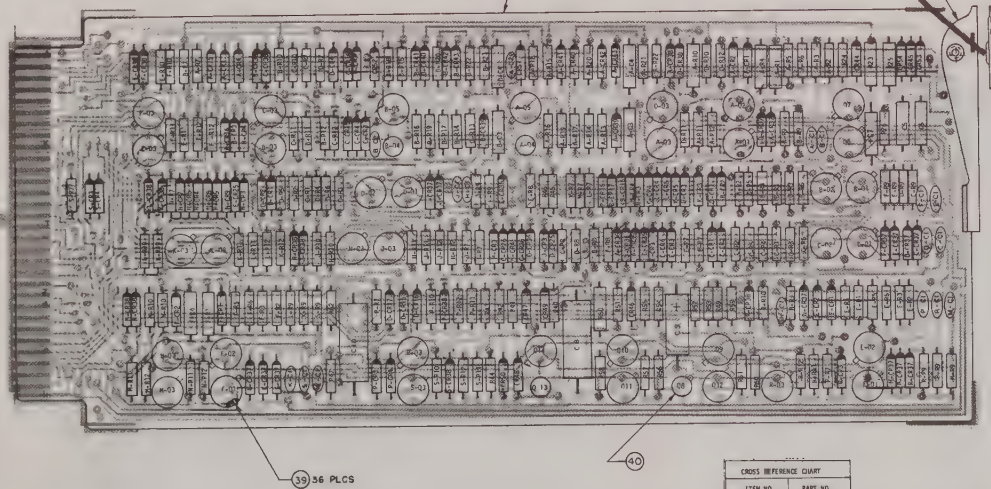
CODE IDENT NO.	SIZE	430251	B
	D		

SCALE NONE | WEIGHT | SHEET 1 of 1

NEXT ASSY	USED ON	NEXT ASSY/FINAL ASSY
APPLICATION		QTY REQD

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA— SUB—ASSY MFR. MAJOR REPL ASSY
MA— MODULE ASSY CA— CMPLETE ASSY

6-19



CROSS REFERENCE CHART	
ITEM NO.	PART NO.
34	410115 M
37	451036
38	610019
39	920006
40	920007

REF DES	B/M ITEM	DESCRIPTION
R50	19	2K 1/2W
R49	12	3.6K
R47	8	24K
R46	8	24K
R45	8	24K
R44	5	150K
R43	4	12K
R42	7	10K
R41	10,9	33K
R40	11	330K
R26	8	24K
R25	18	2.2K 1/2W
R24	8	24K
R23	18	2.2K 1/2W
R22	11	330K
R21	4	12K
R20	5	150K
R19	8	24K
R18	4	12K
R17	5	150K
R16	8	24K
R15	4	12K
R14	5	1K
R13	10	27K
R12	5	150K
R11	8	24K
R10	4	12K
R9	10	27K
R8	5	150K
R7	8	24K
R6	5	150K
R5	8	24K
R4	4	12K
R3	5	150K
R2	8	24K
R1	4	12K

REF DES	B/M ITEM	DESCRIPTION
Q13	28,18	2N3865
Q12	29	2N1304
Q11	29	2N1304
Q10	29	2N1304
Q9	29	2N1304
Q8	26,6	.012
Q7	29	2N1304
Q6	29	2N1304
Q5	29	2N1304
Q4	28,5	2N3646
Q3	29	2N1304
Q2	29	2N1304
Q1	29	2N1304
M-R12	17,3	75K
L-R12	17,3	75K
K-R12	17,3	75K
J-R12	17,3	75K
H-R12	17,3	75K
A-R11	4	12K
A-R10	19,5	4.7K 1/2W
F-R4	19,3	2.7K 1/2W
A-R4	19,5	4.7K 1/2W
F-R3	19,3	2.7K 1/2W
A-R3	19,5	4.7K 1/2W
R62	10	22K
R61	5	150K
R60	14	47K
R59	8	24K
R58	17	680 Ohm
R57	6	16K
R56	13	4.7K
R55	2	11K
R54	7	20K
R53	15	510 Ohm
R52	3	1.2K
R51	4	12K

REF DES	B/M ITEM	DESCRIPTION
CR54	31	1N662
CR53	31	1N662
CR52	31	1N662
CR51	31	1N662
CR50	32	1N751
CR49	31	1N662
CR48	31,5	1N961-B
CR47	31	1N662
CR36	31	1N662
CR25	31	1N662
CR17	31	1N662
CR16	31	1N662
CR15	31	1N662
CR9	31	1N662
CR1	31	1N662
C10	26	.15UF/100V
C9	22	22UF/15V
C8	26	.15UF/100V
C7	23	1.0UF/25V
C6	24	.015UF/100V
C5	24	.015UF/100V
C4	25	.0068UF/100V
C3	27	.0015UF/100V
C2	21	47PF
C1	20	330PF
Q14	29	2N1304

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	
400934		5600-10				
400933		5603				
400932		5640				
400931		5600				

NEXT ASSY | USED ON | NEXT ASSY/FINAL ASSY

APPLICATION | QTY REQD

SYMBOLS: APPLICABLE TO DANA LABORATORIES INC. ONLY. SA—SUB-ASSY. MA—MODULE ASSY. MAJ—MAJOR REPL. ASSY. CA—COMPLETE ASSY.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: X ± .030, XX ± .020, XXX ± .010
ANGLES ± 0° 30'
MATERIAL
APPLIED FINISH

DRAWN	A. MENDOZA	10-17-64
CHECK	T. HANSSEN	11-26-65
ENGR	W. GRIBBLE	2-1-65
APPR		
APPROVED		
APPROVED		

REL 3-6-65
DRN 10 SAM

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C. BOARD ASSEMBLY-PROGRAM, 5600

CODE IDENT NO. —— | SIZE D | 400296 | T

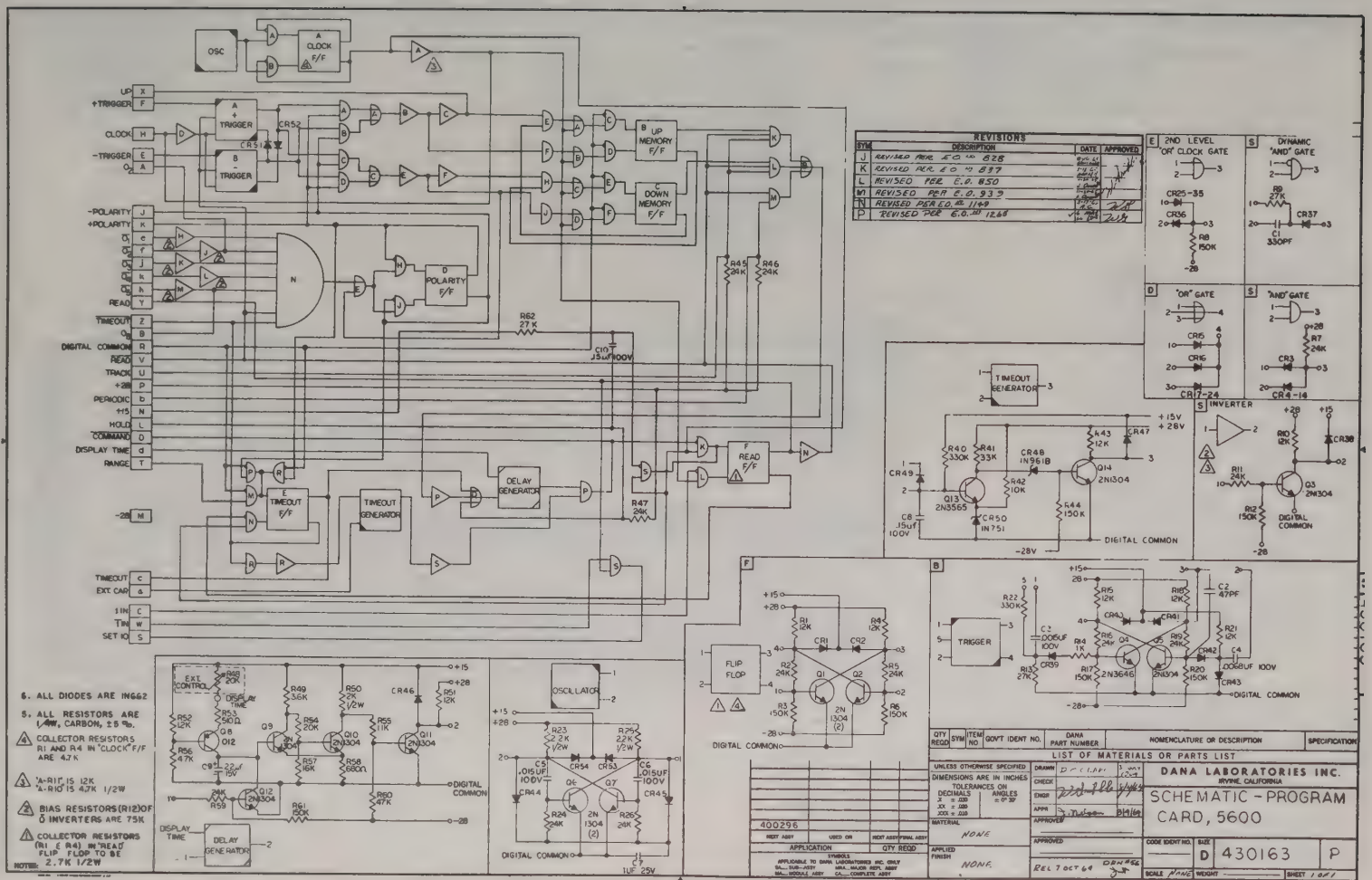
SCALE 2:1 | WEIGHT —— | SHEET ——

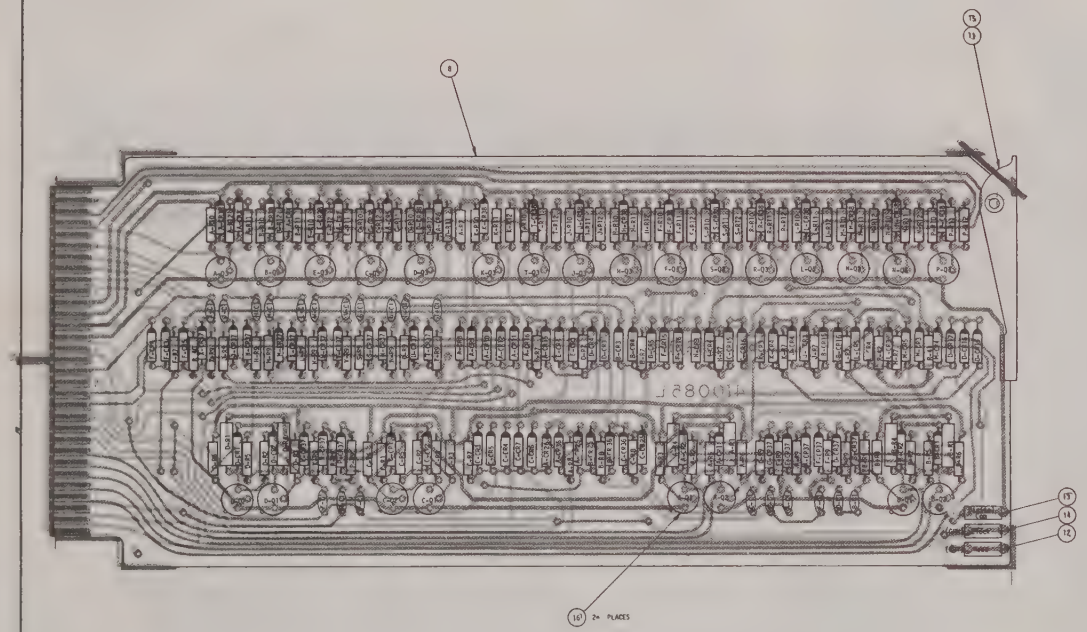
NOTES: UNLESS OTHERWISE SPECIFIED

3. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

2. APP'LI CARD IDENTIFICATION LABEL 920364 (PART OF 400787) TO HANDLE IN LOCATION SHOWN, DURING FINAL ASSEMBLY OF DWM.

1. ALL RESISTORS 1/4 W, CARBON, ±5 %.


OSC
A CLOCK F/F
A TRIGGER
B TRIGGER
B UP MEMORY F/F
C DOWN MEMORY F/F
D POLARITY F/F
E TIMEOUT F/F
F READ F/F
DELAY GENERATOR
TIMEOUT GENERATOR
UP +TRIGGER
CLOCK
-TRIGGER
-POLARITY
+POLARITY
READ
TIMEOUT
DIGITAL COMMON
TRACK
+28
PERIODIC
+15
HOLD
COMMAND
DISPLAY TIME
RANGE
-28
EXT CAR
1 IN
SET IO
R62 27K
C10 .15uf 100V
R45 24K
R46 24K
R47 24K
REVISIONS
SYM DESCRIPTION DATE APPROVED
J REVISED PER E.O. NO 828
K REVISED PER E.O. NO 837
L REVISED PER E.O. 850
M REVISED PER E.O. 933
N REVISED PER E.O. NO 1169
P REVISED PER E.O. NO 1248
E 2ND LEVEL "OR" CLOCK GATE
CR25-35
CR36
R8 150K
S DYNAMIC "AND" GATE
R6 27K
CR37
C1 330PF
D "OR" GATE
CR15
CR16
CR17-24
S "AND" GATE
R7 24K
CR3
CR4-14
TIMEOUT GENERATOR
R40 330K
R41 233K
CR48 IN961B
R43 12K
CR47
Q14 2N1304
CR49
Q13 2N3565
R42 10K
R44 150K
C8 .15uf 100V
CR50 IN751
+15V +28V
-28V
DIGITAL COMMON
S INVERTER
R10 12K
CR38
R11 24K
Q3 2N1304
R12 150K
DIGITAL COMMON
F
FLIP FLOP
R1 12K
R4 12K
CR1
CR2
Q1
Q2
2N 1304 (2)
R2 24K
R5 24K
R3 150K
R6 150K
DIGITAL COMMON
B
TRIGGER
R22 330K
C2 .005uf 100V
R14 1K
R15 12K
R18 12K
CR43
CR41
R16 24K
Q4
Q5
R9 24K
C2 47PF
R21 12K
CR39
R13 27K
R17 150K
2N3646
2N1304
R20 150K
CR42
C4 .0068uf 100V
CR43
DIGITAL COMMON
-28V
6. ALL DIODES ARE IN662
5. ALL RESISTORS ARE 1/4W, CARBON, ±5%.
4. COLLECTOR RESISTORS R1 AND R4 IN "CLOCK" F/F ARE 4.7K
3. 'A-R11' IS 12K 'A-R10' IS 4.7K 1/2W
2. BIAS RESISTORS(R12)OF 0 INVERTERS ARE 75K
1. COLLECTOR RESISTORS (R1 & R4) IN "READ" FLIP FLOP TO BE 2.7K 1/2W
NOTES:
EXT CONTROL
R48 20K
DISPLAY TIME
R52 12K
R53 560Ω
Q8 Q12
R56 47K
C9 .22uf 15V
R49 3.6K
R50 2K 1/2W
CR46
R51 12K
Q9 2N 1304
R54 20K
Q10 2N1304
R55 11K
Q11 2N1304
R57 6K
R58 680Ω
R60 47K
R59 24K
Q12 2N1304
R61 150K
DISPLAY TIME
DELAY GENERATOR
DIGITAL COMMON
OSCILLATOR
R23 2.2K 1/2W
R25 2.2K 1/2W
C5 .015UF 100V
CR54
CR53
C6 .015UF 100V
CR44
Q6
Q7
CR45
2N 1304 (2)
R24 24K
R26 24K
C7 1UF 25V
DIGITAL COMMON
400296
NEXT ASSY
USED ON
NEXT ASSY
FINAL ASSY
APPLICATION
QTY REQD
SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA—SUB-ASSY MA—MAJOR REPL. ASSY
BA—BOOKAGE ASSY CA—COMPLETE ASSY
QTY REQD | SYM | ITEM NO. | GOVT IDENT NO. | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | SPECIFICATION
LIST OF MATERIALS OR PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS X ± .020 .XX ± .010 .XXX ± .005
ANGLES ± 0° 30'
MATERIAL NONE
APPLIED FINISH NONE
DRAWN D. CLARK 1 OCT 64
CHECK
ENGR
APPR
APPROVED
REL 7 OCT 64
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC - PROGRAM CARD, 5600
CODE IDENT NO. 430163
SIZE D
P
SCALE NONE
WEIGHT
SHEET 1 OF 1



REF DES	B/M ITEM	DESCRIPTION
C-R1	4,5	8,2 K
L-R10	4,1	5,6 K
F-R12	4,3	75 K
D-R12	4,3	75 K
C-R12	4,3	75 K
B-R12	4,3	75 K
A-R12	4,3	75 K
R 42	3	24 K
R-41	3	24 K
R 40	3	24 K
R 12	2	150 K
R 11	3	24 K
R 10	1	12 K
R 9	4	27 K
R 8	2	150 K
R 7	3	24 K
R 6	2	150 K
R 5	3	24 K
R 4	4,6	3K 1/2W
R 3	2	150 K
R 2	3	24 K
R 1	4,6	3K 1/2W

REF DES	B/M ITEM	DESCRIPTION
Q 3	6	2N1304
Q 2	6	2N1304
Q 1	6	2N1304
CR 36	7	018
CR 26		
CR 25		
CR 38		
CR 37		
CR 17		
CR 16		
CR 15		
CR 12		
THRU		
CR 1	7	018
C 1	5	330 mf
D-R 4	4,8	2,7 K 1/2 W
D-R 1	4,8	2,7 K 1/2 W
C-R 4	4,5	8,2 K

CROSS REFERENCE CHART

Item No.	Parts No
8	410085L
11	451036
12	600142
13	600144
14	600145
15	610019
16	920006

5 SCHEMATIC REFERENCE: 430166

4. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

3. APPLY CARD IDENTIFICATION LABEL, 920163 (PART OF 430787) TO HANDLE IN LOCATION SHOWN, DURING FINAL ASSEMBLY OF DEV.

2. All diodes to be 914.

1. All resistors to be 1/4W, ± 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	SYM	ITEM NO.	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES

TOLERANCES ON

DECIMALS	ANGLES
.XX ± .030	± 0° 30'
.XX ± .020	
.XXX ± .010	

FORMED ANGLES ± 1.0°

ECCENTRICITY BETWEEN DIA ON THE SAME AXIS SHALL NOT EXCEED .010 TIR.

INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL-D-1000 AND MIL-D-70327

CONTRACT NO.

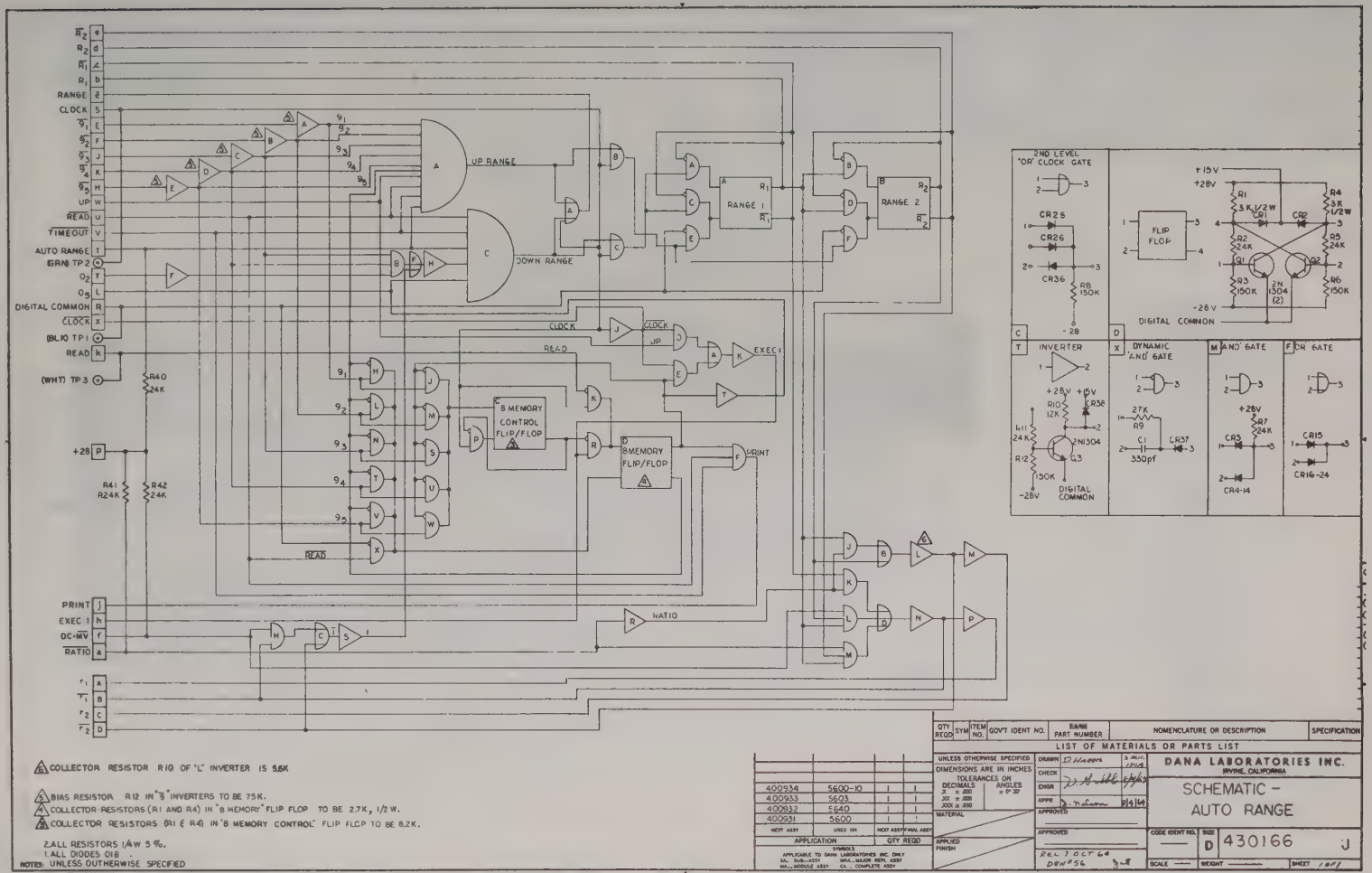
	NAME	DATE
DR	W. Eoie	15 Sept 66
CHK		
APPD		

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C. BOARD ASSY-
AUTO RANGE

SIZE	CODE IDENT NO.	DWG NO.	
D	—	400297	N

SCALE 2/1 WT — SHEET 1 OF 1



⚠5 COLLECTOR RESISTOR R10 OF 'L' INVERTER IS 5.6K

⚠3 BIAS RESISTOR R12 IN '8' INVERTERS TO BE 7.5K.
⚠4 COLLECTOR RESISTORS (R1 AND R4) IN '8 MEMORY' FLIP FLOP TO BE 2.7K, 1/2 W.
⚠2 COLLECTOR RESISTORS (R1 & R4) IN '8 MEMORY CONTROL' FLIP FLOP TO BE 8.2K.

2. ALL RESISTORS 1/4W 5%.
1. ALL DIODES 018 .
NOTES: UNLESS OUTHERWISE SPECIFIED

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	
400934		5600-10				
400933		5603				
400932		5640				
400931		5600				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS X ± .020, XX ± .010, XXX ± .005, ANGLES ± 0° 30'

MATERIAL

APPLIED FINISH

NEXT ASSY | USED ON | NEXT ASSY/FINAL ASSY

APPLICATION | QTY REQD

SYMBOLS: APPLICABLE TO DANA LABORATORIES INC. ONLY. SA—SUB-ASSY, MA—MAJOR ASSY, MA—MODULE ASSY, CA—COMPLETE ASSY

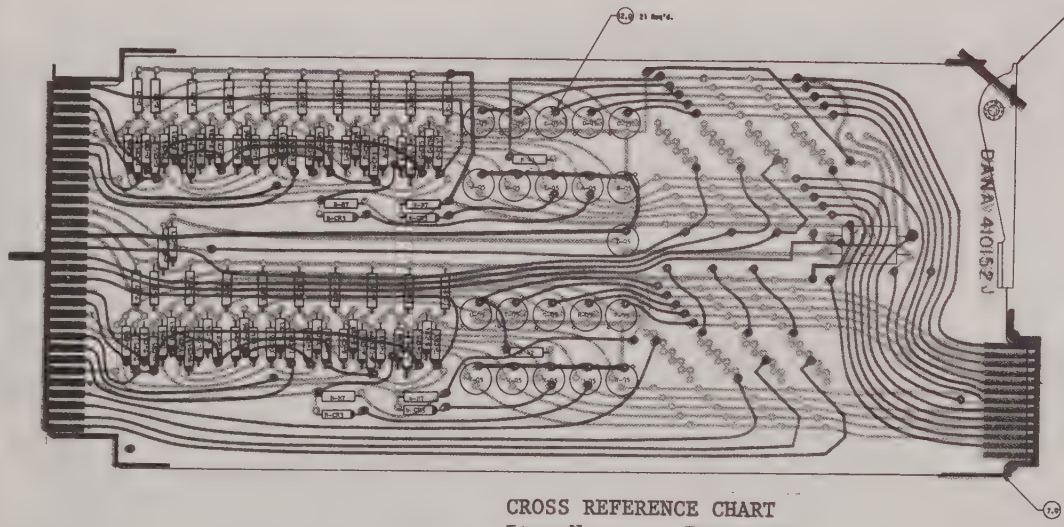
DRAWN D. Nixon 3 AUG 1964
CHECK
ENGR
APPR D. Nixon 8/4/64
APPROVED
APPROVED
REL 7 OCT 64 DEN #56

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC – AUTO RANGE

CODE IDENT NO. — | SIZE D | 430166 | J

SCALE — | WEIGHT — | SHEET 1 of 1



REF DES	ITEM	DESCRIPTION
R 5	4.6	816
R 43	3.0	20 K 1W
R 42	1.0	2 Meg
R 41	1.0	2 Meg
R 40	3.0	20 K 1W
R-37	1.6	34 K
R-37	1.5	33 K
R-37	1.5	33 K
R-37	1.5	33 K
R 7	2.0	24 K
CR 6	6.0	1N642
CR 5	6.0	1N642
CR 4	6.0	1N642
CR 3	6.0	1N642

CROSS REFERENCE CHART

Item No.	Parts No.
7.0	410152J
10.0	451036
11.0	610019
12.0	920006
13.0	920010

5. SCHEMATIC REFERENCE: 430271
4. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.
3. APPLY CODE IDENTIFICATION LABEL 920134 (PART OF 680787) TO HANDLE IN LOCATION SHOWN, DURING FINAL ASSEMBLY OF DPA.
2. R-87, R-87, R-87 and R-87 are to be 15K, (R/M item 1.6)
1. ... resistors are carbon, 1/4w, 2%

NOTES: unless otherwise specified

400605	5603	2	REF
539			
528			
494	5603		
496	5600		
422			
464			
400529	5600	2	REF
NEXT ASSY	USED ON	NEXT ASSY/FINAL ASSY	

APPLICATION — QTY REQD

SYMBOLS: APPLICABLE TO DANA LABORATORIES INC. ONLY. SA—SUB-ASSY, MIN.—MINOR ITEM, ASSY; MA—MODULE ASSY, CA—COMPLETE ASSY

QTY REQD	SYM	ITEM NO.	GOV'T IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS X = .020, XX = .010, XXX = .010; ANGLES = 0° 30'

MATERIAL: SEE L/M

FINISH

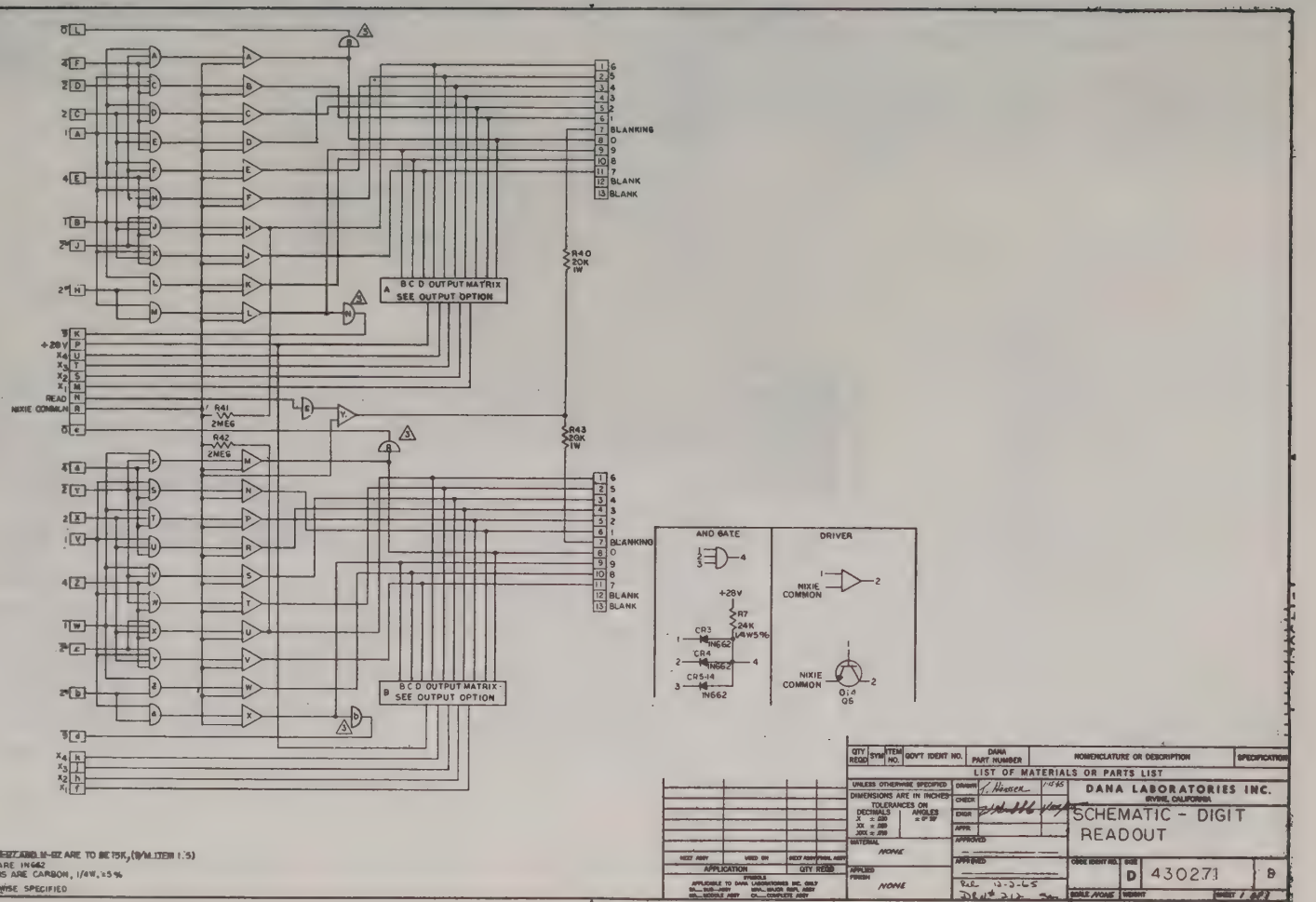
APPLIED

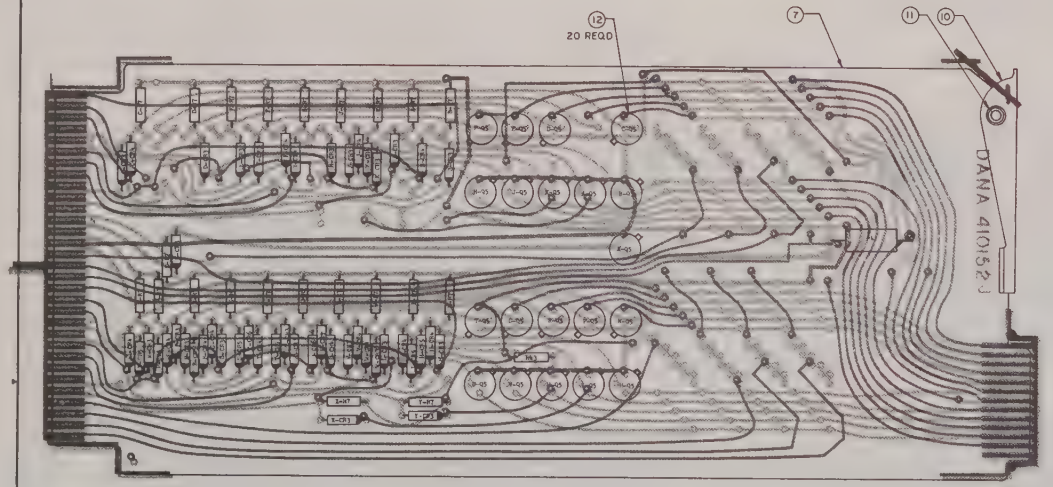
DRAWN J. Hanneken 3-29-65
CHECK E. M. Nunez 3-30-65
ENGR W. Chantler 3/12
APPR
APPROVED
APPROVED
7-7-65

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C. BOARD ASS'Y
DIGIT READOUT, BASIC

CODE IDENT NO. —
SIZE D
400463
L
SCALE 2:1
WEIGHT —
SHEET 1 OF 1


BCD OUTPUT MATRIX
SEE OUTPUT OPTION
A
B
R40
20K
1W
R41
2MEG
R42
2MEG
R43
20K
1W
BLANKING
BLANK
BLANK
READ
NIXIE COMMON
+28V
AND GATE
DRIVER
NIXIE
COMMON
R7
24K
1/8W 5%
CR3
IN662
CR4
IN662
CR5
IN662
Q1
Q5
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE CARBON, 1/4W, ±5%
2. ALL DIODES ARE IN662
3. R-R1, R-R7, R-R27 AND R-R2 ARE TO BE 15K, (P/N ITEM 1.5)
LIST OF MATERIALS OR PARTS LIST
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC - DIGIT READOUT
D
430271
B



T-R7	1a	15K
R-R7	1a	15K
	4a2	01K
	1	1.1K
	1	1.1K
	1	1.1K
		1.1K
	1	1
	3	10K 1%
	2	24K
REF DES	QTY PER ASSY	VALUE

EXCEPT R-R7 & T-R7

CROSS REFERENCE CHART

Item No.	Parts No.
7.0	410152J
10.0	451036
11.0	610019
12.0	920006
13.0	920010

4. ASSEMBLY PROCEDURES AND PROCESSES TO [illegible]

3. APPLY CAGE IDENTIFICATION LABEL 959120 (PART OF 400787) TO HANDLE ID LOCATION SHOWN, DURING FINAL ASSEMBLY OF DWG.

2. R-R7 and T-R7 are 10K resistors.

1. ALL RESISTOR ARE 1/4W, CARBON, ±5 %.

NOTES: UNLESS OTHERWISE SPECIFIED

400495	5603	1	REF		
606					
538					
539	5603				
529	5600				
468					
469					
400470	5600	1	REF		
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY		

APPLICATION — QTY REQD

SYMBOLS: APPLICABLE TO DANA LABORATORIES INC. ONLY. SA—SUB-ASSY, MRA—MAJOR REPL ASSY, MA—MODULE ASSY, CA—COMPLETE ASSY

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	

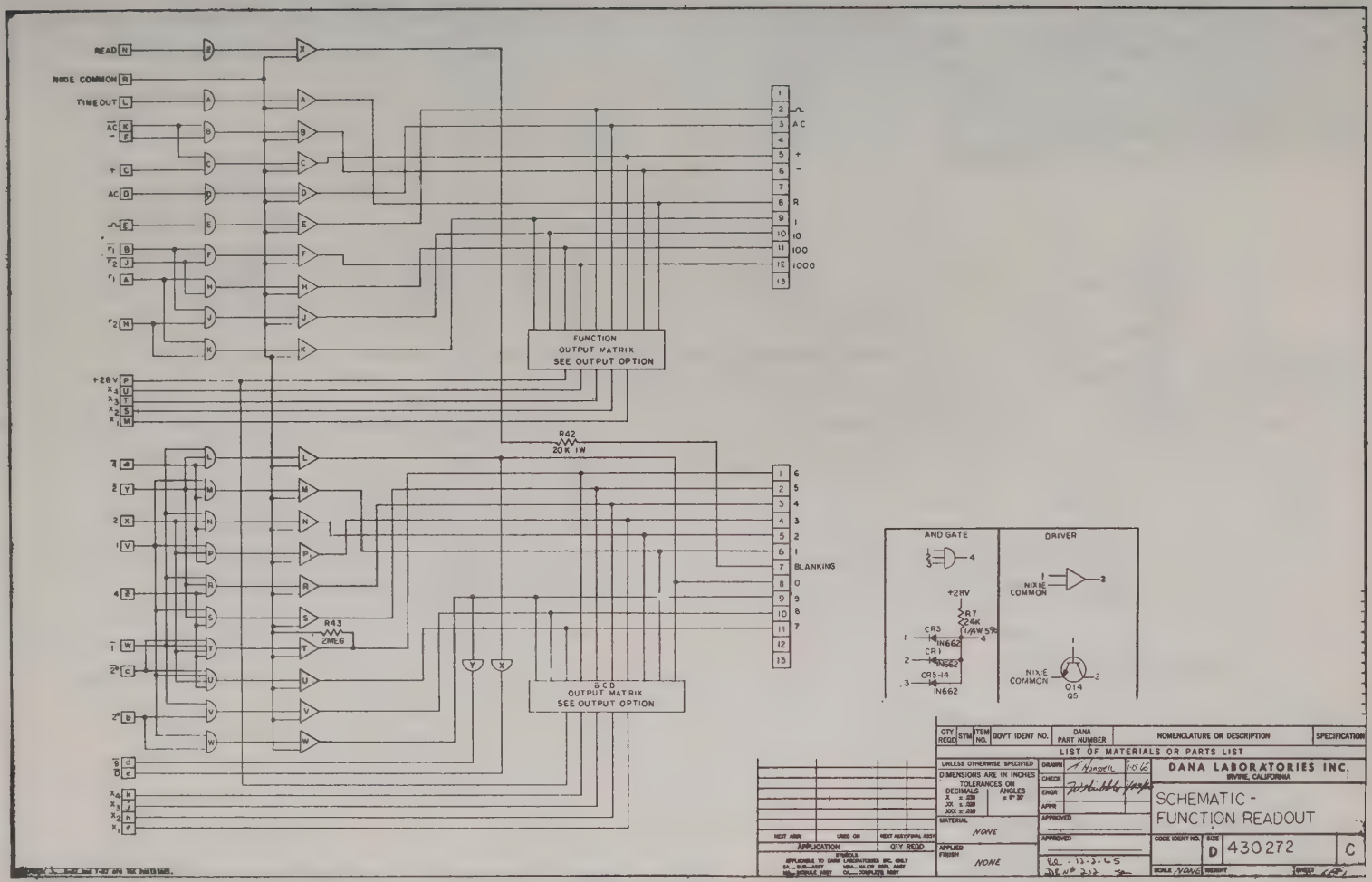
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS X ± .030, XX ± .010, XXX ± .010; ANGLES ± 0° 30'
MATERIAL: SEE L/M
APPLIED FINISH

DRAWN	G. Smith	5/16/62
CHECK	R. Lewis	6-20-62
ENGR	D. Hobbs	6/20
APPR		
APPROVED		
APPROVED	P.C. 7-6-62	

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P. C. BOARD ASSY—
READOUT CARD

CODE IDENT NO. ——— SIZE D 400467 M
SCALE 2/1 WEIGHT ——— SHEET 1 OF 1



QTY REQD	SYM	ITEM NO.	GOV'T IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS X ± .030, .XX ± .010, .XXX ± .005
ANGLES ± 0° 30'

DRAWN T. Hansen 10/6/65
CHECK
ENGR
APPR
APPROVED
APPROVED

MATERIAL NONE
APPLIED FINISH NONE

Rev. 12-2-65
DR No. 2-12

NEXT ASSY | USED ON | NEXT ASSY FINAL ASSY
APPLICATION | QTY REQD

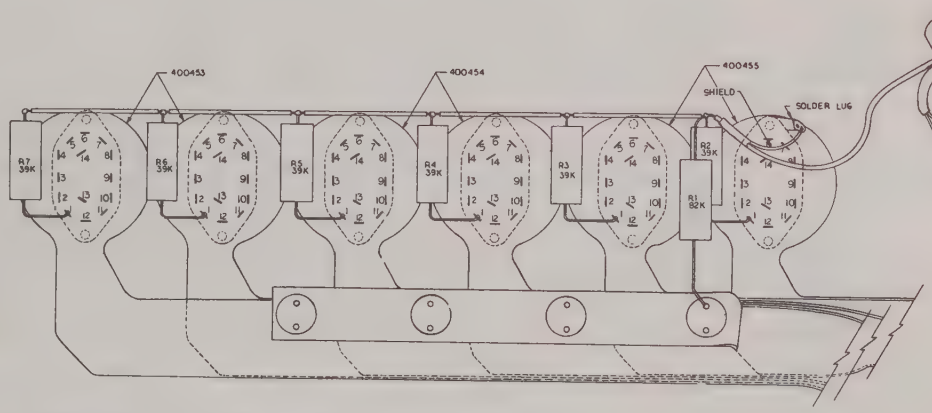
SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA—SUB-ASSY MA—MAJOR ASSY
MA—MODULE ASSY CA—COMPLETE ASSY

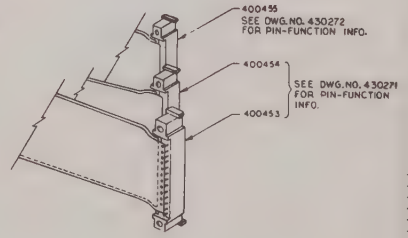
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC - FUNCTION READOUT

CODE IDENT NO. | SIZE D | 430272 | C

SCALE NONE | WEIGHT | SHEET 1 OF 1





DIGIT READOUT	
PIN	CHARACTER
1	+VOLTAGE
2	NUMERAL 0
3	9
4	8
5	7
6	6
7	5
8	4
9	3
10	2
11	NUMERAL 1

FUNCTION READOUT	
PIN	CHARACTER
1	+VOLTAGE
2	"+"
3	"−"
4	"R"
5	—
6	—
7	—
8	—
9	—
10	"Ω"
11	"AC"

NOTES:

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS X ± .020, XX ± .010, XXX ± .005; ANGLES ± 0° 30'

MATERIAL

APPLIED FINISH

DRAWN T. HANSEN 1-6-65
CHECK
ENGR
APPR
APPROVED

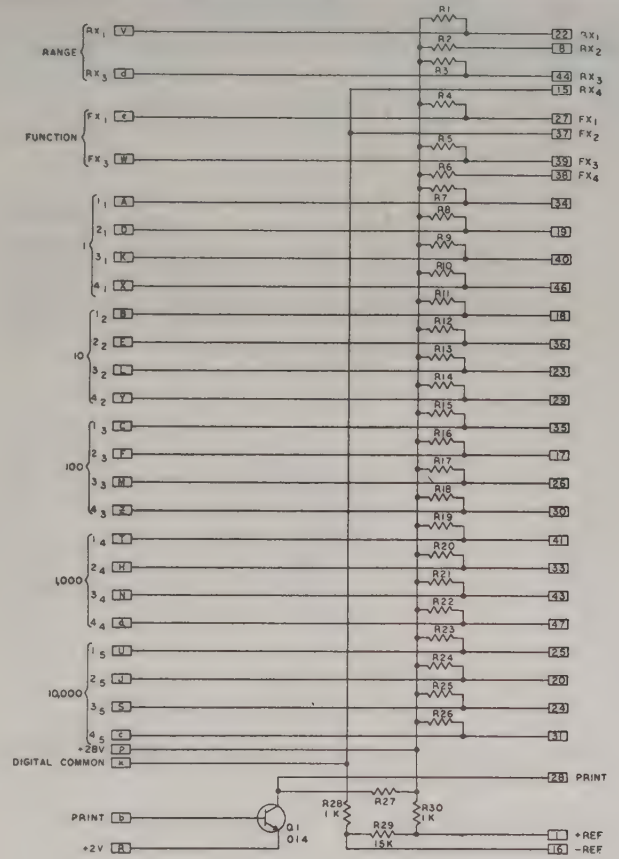
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

WIRING DIAGRAM - READOUT PANEL, 5600

CODE IDENT NO. —
SIZE D
430259
A
SCALE —
WEIGHT —
SHEET 1 OF 1

NEXT ASSY	USED ON	NEXT ASSY/FINAL ASSY
APPLICATION		QTY REQD

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA — SUB-ASSY MFA — MAJOR REPL ASSY
MA — MODULE ASSY CA — COMPLETE ASSY



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE 47K, 1/4W, CARBON, ± 5%

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

QTY REQD	SYM	ITEM NO.	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: .X ± .100, .XX ± .010, .XXX ± .010
ANGLES: ± 0° 30'
FORMED ANGLES ± 1.0°
ECCENTRICITY BETWEEN DIA ON THE BASE ARE SHALL NOT EXCEED .010 TIR.
INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL D-1000 AND MIL D-70327

CONTRACT NO.

	NAME	DATE
DR	CHAUSSE	5-24-66
CHK		
APPD		

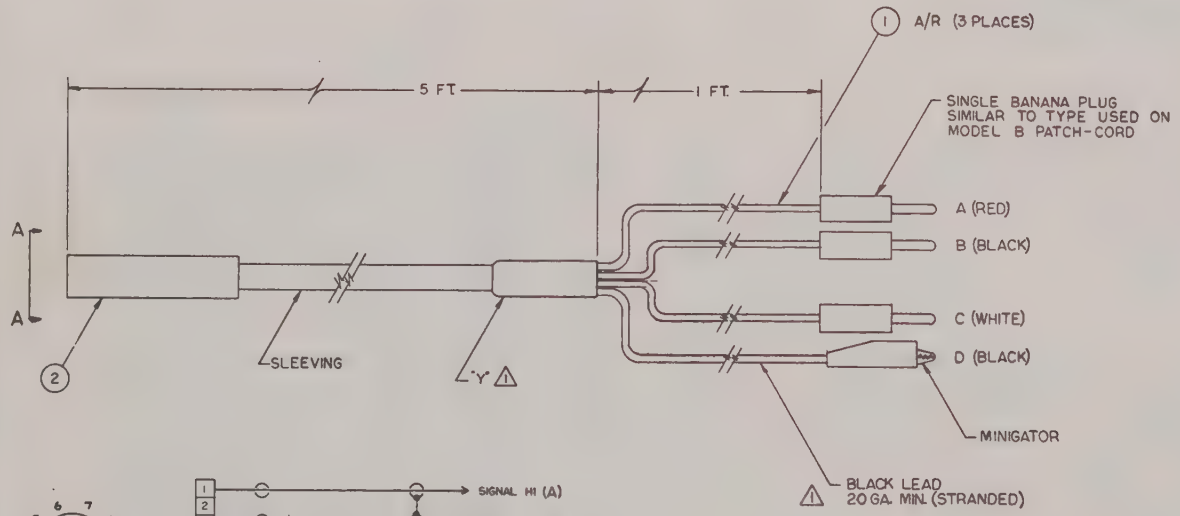
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

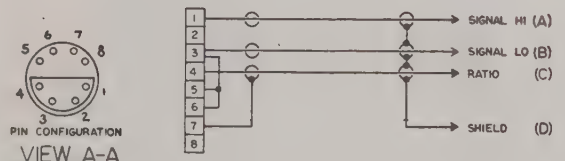
SCHEMATIC - PRINTER OPTION
HI-S-638

SIZE: D | CODE IDENT NO. | DWG NO. 190180

SCALE — | WT — | SHEET 1 OF 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED





QTY REQD	SYM	ITEM NO.	GOV'T OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION
1		2		S-0155	CONNECTOR PLUG – AUTO. METAL PROD.	#P3-8M13	
A/R		1		500021	1 COND. SHIELDED TEFLON INSUL.– STORM		

2

LIST OF MATERIAL OR PARTS LIST

2 ITEMS 1 & 2 TO BE SUPPLIED BY DANA LABS.

1 CONNECT SHIELD LEAD TO BRAID OF SIGNAL LEADS WITHIN "Y"

NOTES: UNLESS OTHERWISE SPECIFIED

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: X ± .030, XX ± .020, .XXX ± .010
ANGLES ± 0° 30'
FORMED ANGLES ± 1.0°
ECCENTRICITY BETWEEN DIA ON THE SAME AXIS SHALL NOT EXCEED .010 TIR.
INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL-D-1000 AND MIL-D-70327

CONTRACT NO.

	NAME	DATE
DR	W. Edis	10 MAY 1966
CHK	D Trumbo	10 May 66
APPD	J. Nelson	10 MAY 66

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

INPUT CABLE, 5600-S-638

SIZE	CODE IDENT NO.	DWG NO.
C	———	190159

SCALE ——— WT ——— SHEET 1 OF 1

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED

PRINTER DRIVER ASSY
S-0182

P/N 600017

J202-12 — J202-25
J202-10
J202-5 — J202-7
J202-9 — J202-6
J202-8 — J202-14
J202-4
J202-29 — J202-1
J202-28 — J202-32
J202-30 — J202-2
J202-38
J202-11 — J202-13
J202-34
J202-36 — J202-3
J202-26 — J202-48
J202-33
J202-31 — J202-35
J202-37 — J202-27
J202-39
J202-24

X_3 X_4	X_1 X_2	RANGE
X_3 X_4	X_1 X_2	SIGN & FUNCTION
X_3 X_4	X_1 X_2	1
X_3 X_4	X_1 X_2	10
X_3 X_4	X_1 X_2	100
X_3 X_4	X_1 X_2	1000
X_3 X_4	X_1 X_2	10 000

PRINT COMMAND — − REFERENCE / + REFERENCE

MAGNETIC SHIELD P/N 600174 TIED TO ELECTROSTATIC SHIELD OF RELAY.

CONNECTOR P/N 600130

A B C H E D

K26 — COMMAND RELAY COIL INPUT 12 VDC — J204

LOCATED ON PC BOARD S-0178 MOUNTED TO PLATE ADAPTER

49 50 51

LEFT SIDE OF S-0178 SAME SIDE AS RIGHT SIDE

S-0181

QTY REQD	SYM	ITEM NO.	GOV'T IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION

LIST OF MATERIALS OR PARTS LIST

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
	5600		
APPLICATION		QTY REQD	

INDEX
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA—SUB—ASSY MRA—MAJOR REPL ASSY
MA—MODULE ASSY CA—COMPLETE ASSY

UNLESS OTHERWISE SPECIFIED	DRAWN	W. Eoie	21 MAY 1966
DIMENSIONS ARE IN INCHES	CHECK		
TOLERANCES ON DECIMALS: X ± .030, XX ± .020, XXX ± .010; ANGLES ± 0° 30'	ENGR		
	APPR		
MATERIAL	APPROVED		
APPLIED FINISH	APPROVED		

DANA LABORATORIES INC.
SANTA ANA, CALIF.

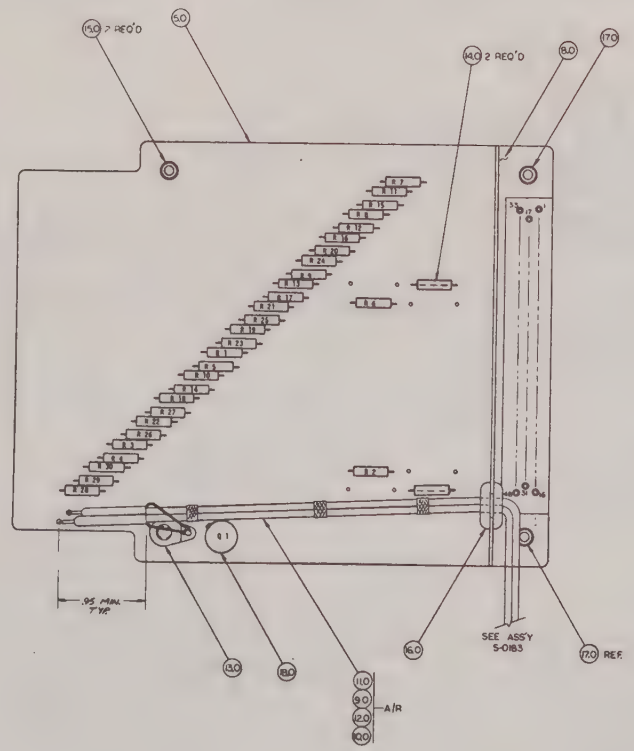
WIRING DIAGRAM - PRINTER OPT. HI S638 5600

CODE IDENT NO.	SIZE	
	C	190181
SCALE NONE	WEIGHT	SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL WIRE 24 GA WHITE PVC HOOKUP

6-31

LIETZ 1110 TOPPLIGHT 10-62



REF DES	QTY REQ'D	ITEM NO.	DESCRIPTION
R 30	1.0	1	
R 29	2.0	15	
R 28	1.0	1	
R 27	3.0	47	
THRU			
R 1	3.0	47	
Q 1	4.0	035	

CROSS REFERENCE CHART

Item No.	Parts No.
5.0	S-0178
8.0	450457A
9.0	500002
10.0	500005
11.0	501446
12.0	524000
13.0	600022
14.0	600245
15.0	610020
16.0	610027
17.0	610115
18.0	920008

QTY REQD	SYM	ITEM NO.	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

1 RESISTORS TO BE 1/4 W. ± 5%, CARBON

NOTES: UNLESS OTHERWISE SPECIFIED

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS | ANGLES
.X ± .030 | ± 0° 30'
.XX ± .020
.XXX ± .010
FORMED ANGLES ± 1.0°
ECCENTRICITY BETWEEN DIA ON THE SAME AXIS SHALL NOT EXCEED .010 TIR.
INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL-D-1000 AND MIL-D-70327

CONTRACT NO.

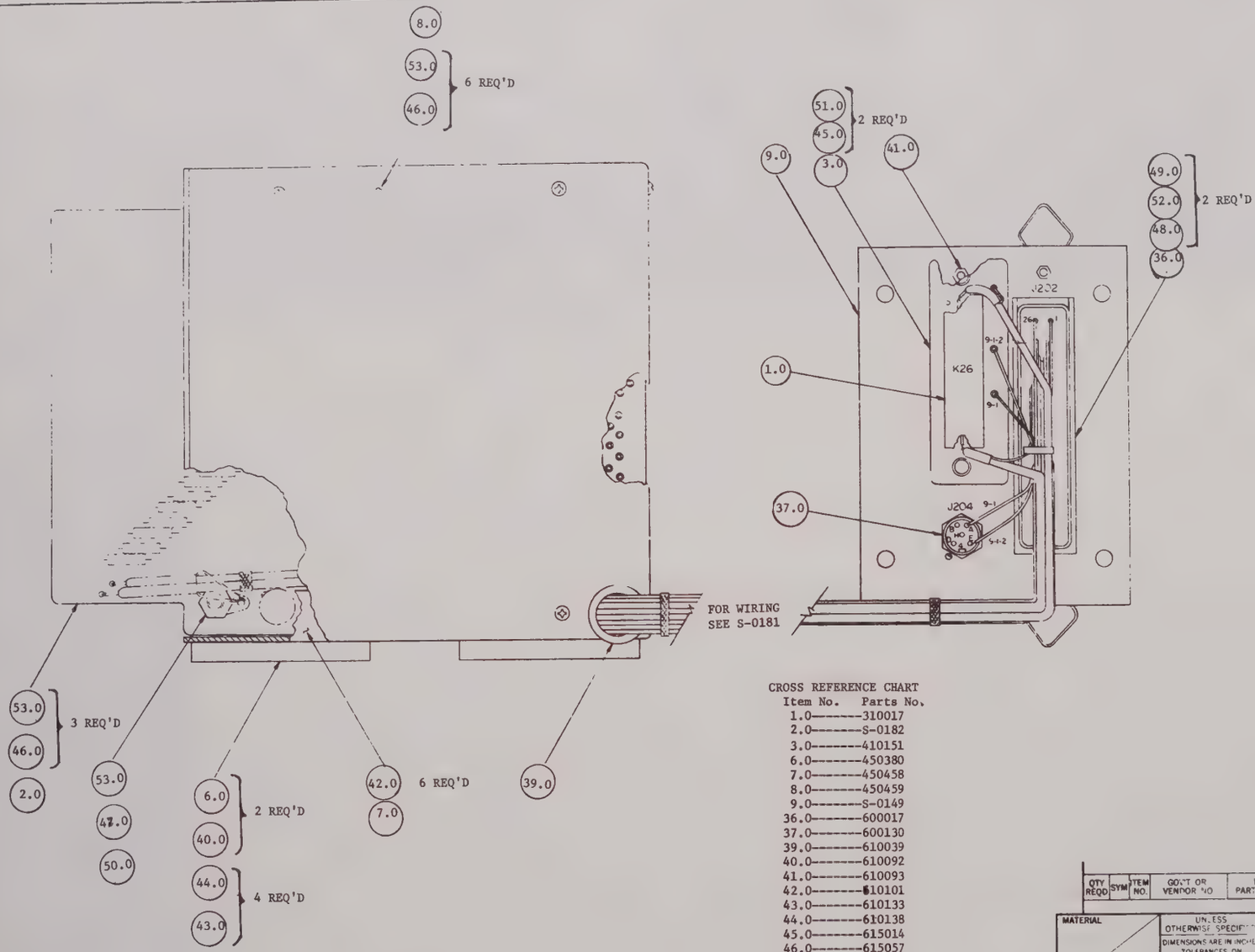
	NAME	DATE
DR	W. E. O'K	25 MAY 1969
CHK		
APPD		

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C. BOARD ASS'Y-
PRINTER DRIVER CPT. HI-S638

SIZE	CODE IDENT NO.	DWG NO.
D	—	190182

SCALE 4/1 | WT — | SHEET 1 OF 1



CROSS REFERENCE CHART

Item No.	Parts No.
1.0	310017
2.0	S-0182
3.0	410151
6.0	450380
7.0	450458
8.0	450459
9.0	S-0149
36.0	600017
37.0	600130
39.0	610039
40.0	610092
41.0	610093
42.0	610101
43.0	610133
44.0	610138
45.0	615014
46.0	615057
47.0	615061
48.0	615904
49.0	617003
50.0	617017
51.0	617075
52.0	617076
53.0	617079

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS

DESCRIPTION	DATE	APPROVED

QTY REQD	SYM	ITEM NO.	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS ANGLES
XX ± .010 ± 0°30'
XXX ± .005
FORMED ANGLES ± 1°0'
ECCENTRICITY BETWEEN DIA ON THE SAME AXIS SHALL NOT EXCEED .01
INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL D 10 AND MIL D 7032

NAME DATE

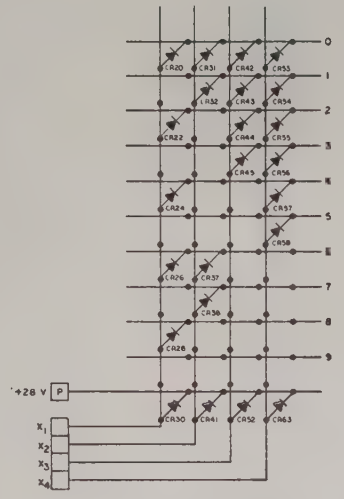
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

[illegible] DRIVER ASSY-
710[illegible]

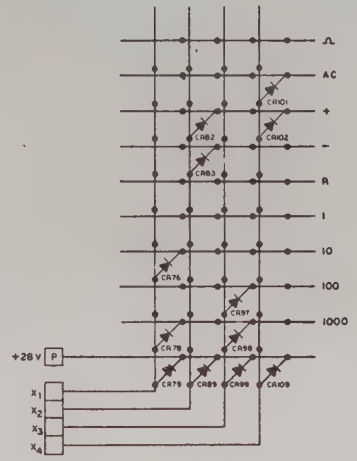
SIZE D | CODE IDENT NO. [illegible] | DWG NO. [illegible]0193

SCALE 1 WT - SHEET 1 OF 1

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED



BCD OUTPUT MATRIX



FUNCTION OUTPUT MATRIX

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
LIST OF MATERIALS OR PARTS LIST						

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS
ANGLES

DRAWN	W. E. Dale
CHECK	
ENGR	
APPR	
MATERIAL	
APPROVED	
APPROVED	
APPLIED FINISH	

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC – MATRIX PRINTER OPTION HI-S638

CODE IDENT NO. —— SIZE D 190186

SCALE —— WEIGHT —— SHEET 1 OF 1

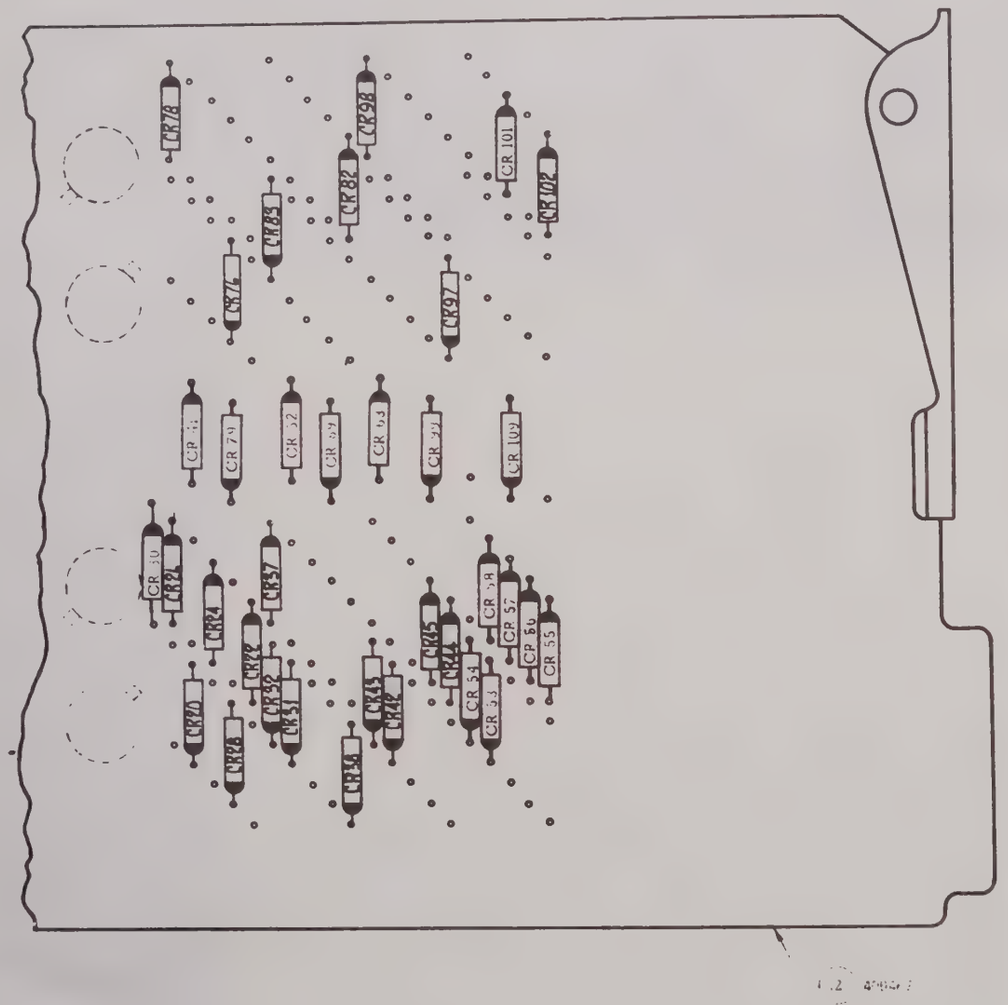
NEXT ASSY | USED ON | NEXT ASSY/FINAL ASSY

APPLICATION | QTY REQD

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA — SUB-ASSY
MRA — MAJOR REPL ASSY
SA — MODULE ASSY
CA — COMPLETE ASSY

NOTES.

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED



REF DES	B/M ITEM	DESCRIPTION
CR50	1	1N662
CR49		
CR48		
CR47		
CR46		
CR41		
CR40		
CR39		
CR38		
CR35		
CR34		
CR33		
CR30		
CR29		
CR27		
CR26		
CR25		
CR22		
CR21		1N662

REF DES	B/M ITEM	DESCRIPTION
CR109	1	1N662
CR103		
CR101		
CR99		
CR96		
CR95		
CR89		
CR81		
CR80		
CR79		
CR77		
CR75		
CR63		
CR58		
CR57		
CR56		
CR55		
CR54		
CR53		
CR52		
CR51	1	1N662

REF: 400488

QTY REQD	SYM	ITEM NO.	GOV'T IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY	QTY REQD
	S-638			

APPLICATION

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
CA ... ASSY MRA ... MAJOR REPL ASSY
MA ... MODULE ASSY CA ... COMPLETE ASSY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: .X ± .030, .XX ± .020, .XXX ± .010
ANGLES

MATERIAL
SEE [illegible]

APPLIED FINISH

DRAWN	M McKray	9-26-68
CHKR		
APPR		
APPROVED		
APPROVED		

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

PC BOARD ASSY - FUNCTION READOUT OPT H-1 S-638

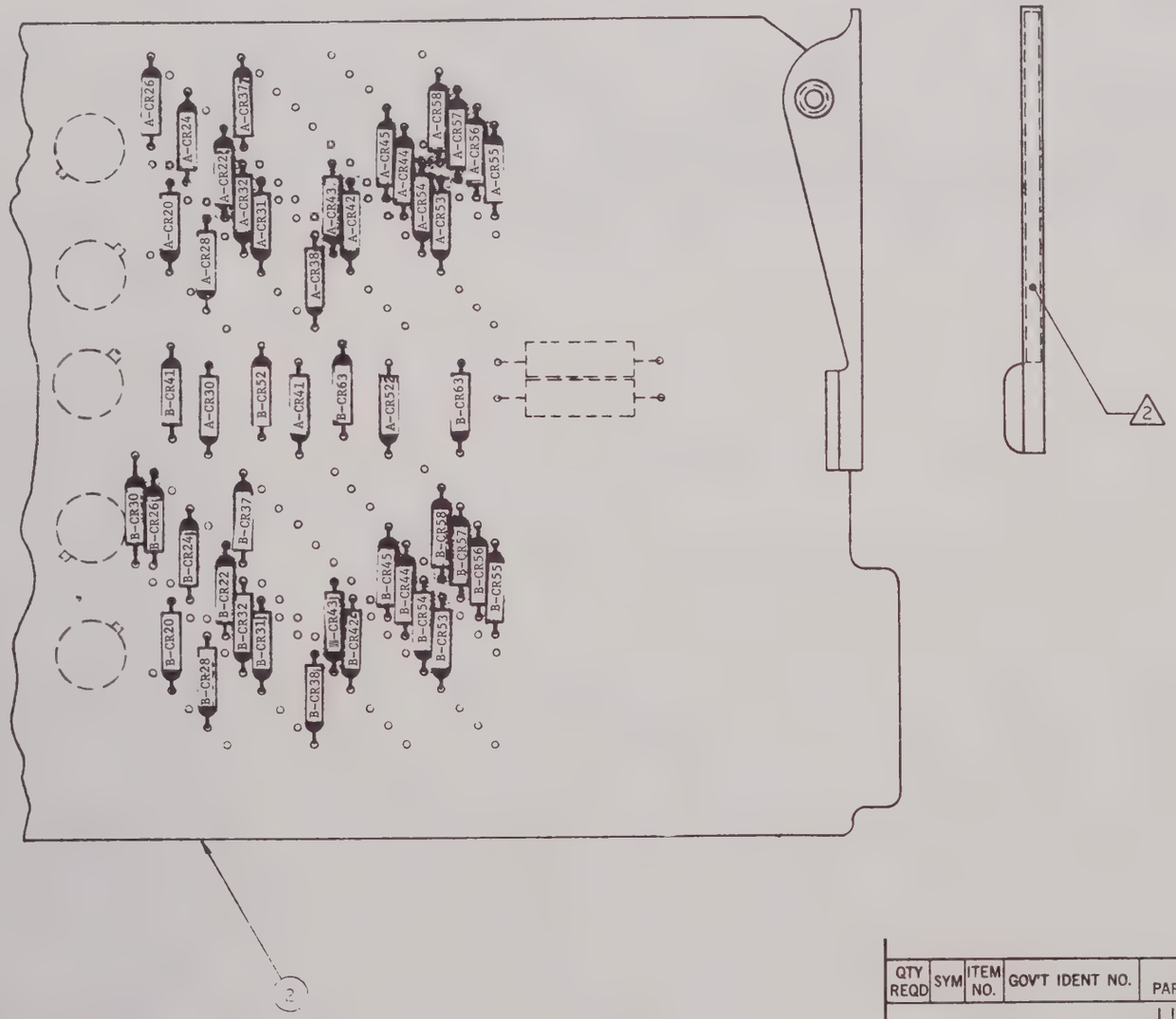
CODE IDENT NO	SIZE		
[illegible]	C	191162	1
SCALE [illegible]	WEIGHT	SHEET 1 OF 1	

/1. AFFIX CARD IDENTIFICATION LABEL 920140 (PART OF A507871) TO HANDLE IN LOCATION SHOWN, DURING FINAL ASSEMBLY OF DVM.

NOTES: UNLESS OTHERWISE SPECIFIED

506-10 DIETZ 1530 TOPSTITCH 3-64

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED



400870

QTY REQD	SYM	ITEM NO.	GOV'T IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION

LIST OF MATERIALS OR PARTS LIST

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA ..... SUB -ASSY MRA... MAJOR REPL ASSY
MA..... MODULE ASSY CA..... COMPLETE ASSY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: X ± .030, .XX ± .020, .XXX ± .010
ANGLES: ± 0° 30'

MATERIAL

APPLIED FINISH

DRAWN	W. EDIE	21 FEB 1964
CHECK	[illegible]	25 FEB 64
ENGR	[illegible]	[illegible]
APPR		

APPROVED

APPROVED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

PC BOARD ASS'Y-
DIGIT READOUT
OPT H-5

CODE IDENT NO.	SIZE	
	C	400870

SCALE [illegible] | WEIGHT | SHEET 1 OF 1

2. AFFIX CARD IDENTIFICATION LABEL 920137 (PART OF 450787) TO HANDLE IN LOCATION SHOWN DURING FINAL ASSEMBLY OF DVM.

1. DIODES TO BE IN662

NOTES: UNLESS OTHERWISE SPECIFIED

986-00 LIETZ 1036 TOPELIGHT 4 64

List of Manufacturers

Federal Supply Code	Manufacturer
00656	Aerovox Corp. New Bedford, Massachusetts
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01295	Texas Instruments, Inc. Dallas, Texas
03888	Pyrofilm Resistor Co., Inc. Cedar Knolls, New Jersey
04713	Motorola Semiconductor Phoenix, Arizona
05397	Kemet Dept., Linde Co., Div. of Union Carbide Cleveland, Ohio
07088	Kelvin, Van Nuys, California
07263	Fairchild Semiconductor Corp. Palo Alto, California
07716	International Resistance Co. Burlington, Iowa
14655	Cornell-Dubilier Electric Corp. South Plainfield, New Jersey
17826	Techno Components Corp. Northridge, California
56289	Sprague Electric Co. North Adams, Massachusetts
71785	Cinch Manufacturing Co. Chicago, Illinois
71590	Centralab Division of Globe Union, Inc. Milwaukee, Wisconsin

List of Manufacturers

Federal Supply Code	Manufacturer
80294	Bourns Laboratories, Inc. Riverside, California
73490	Helipot Div., Beckman Instruments, Inc. Fullerton, California
09026	Babcock Relays Division, Babcock Electronics Corp., Costa Mesa, California
02116	Wheelock Signals, Inc. Long Branch, New Jersey
00213	Sage Electronics Corp. Rochester, New York
	Jedco Manufacturing Co. Northridge, California
70309	Allied Control Co., Inc. New York, New York
	Dana Laboratories, Inc. Irvine, California

PARTS LIST

Printed Circuit Board Assembly, Lower Order Decade — Dana 400436

Reference Designator	Description	Manufacturers'		Dana
		FSC	Part No.	Part No.
C1	Capacitor, Ceramic disc, 330pF, 10%	00656	SCD1X5F	101098
CR1 thru CR70	Diode, 1N662	07263	1N662	211083
Q1 thru Q11	Transistor, 2N1304	01295	2N1304	201084
R1	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R2	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R3	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R4	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R5	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R6	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R7	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
C-R7	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R8	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R9	Resistor, Comp, 27k, 1/4w, 5%	01121	CB-2735	000273
R10	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R11	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R12	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R13	Resistor, Wire-wound, 100k, .1%	07088	EP21-100k	021104
R14	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R15	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R16	Resistor, Comp, 68k, 1/4w, 5%	01121	CB-6835	000683
R17	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R18	Resistor, Comp, 391, 1/4w, 5%	01121	CB-3935	000393
R19	Resistor, Comp, 68k, 1/4w, 5%	01121	CB-6835	000683
R20	Resistor, Wire-wound, 50k, .05%	07088	EP21-50k	021103
R21	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R22	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R23	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R24	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R25	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R26	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R27	Resistor, Wire-wound, 100k, .1%	07088	EP21-100k	021104

Printed Circuit Board Assembly, Lower Order Decade — Dana 400436
(Cont)

Reference Designator	Description	Manufacturers'		Dana
		FSC	Part No.	Part No.
R28	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R29	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R30	Resistor, Comp, 68k, 1/4w, 5%	01121	CB-6835	000683
R31	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R32	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R33	Resistor, Comp, 68k, 1/4w, 5%	01121	CB-6835	000683
R34	Resistor, wire-wound, 200k,.1%	07088	EP21-200k	021106
R35	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R36	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R37	Resistor, Comp, 68k, 1/4w, 5%	01121	CB-6835	000683
R38	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R39	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R40	Resistor, Comp, 68k, 1/4w, 5%	01121	CB-6835	000683
R41	Resistor, Wire-wound, 180k,.1%	07088	EP21-180k	021105

*

PARTS LIST

Printed Circuit Board Assembly, Null Detector Isolator — Dana 400438

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
C1	Capacitor, tantalum, 100uF, 20%, 10V	05397	K100C10K	110006
C2	Capacitor, metal film, .15uF, 10%, 200V	Jedco	17WC154K	120049
C3	Capacitor, Mylar, .0022uF, 10%, 100V	14655	WMF1D22Myl	121092
C4	Capacitor, disc, .001uF	00656	SCD345F	101174
C6	Capacitor, Polystyrene, .001uF, 500V	71590	CPR1000	120004
C7	Capacitor, tant., 6.8uF, 20%, 35V	05397	K6R8C35K	110001
C8	Capacitor, Polystyrene, 100pF	71590	CPR100	120034
C9	Capacitor, tant., 22uF, 20%, 35V	05397	K22C35K	110002
C10	Capacitor, Mylar, .068uF, 10%, 200V	Jedco	SER17W	120048
C11	Capacitor, tant., 100uF, 20%, 10V	05397	K100C101C	110006
C12	Capacitor, Mylar, .0022uF, 10%, 100V	14655	WMF1D22Myl	121092
C13	Capacitor, Mylar, .22uF, 10%, 100V	14655	WMF1P22E	121393
C14	Capacitor, tant., 22uF, 20%, 35V	05397	K22C35K	110002
C15	Capacitor, Polystyrene, .001uF, 500V	71590	CPR-100J	120004
C16	Capacitor, Mylar, .0068uF, 10%, 100%	14655	1D68	121147
C17	Capacitor, tant., 22uF, 20%, 35V	05397	K22C35K	110002
CR1	Diode, 1N662	01295	1N662	211083
CR2	Diode, 1N662	01295	1N662	211083
CR3	Diode, 1N662	01295	1N662	211083
CR4	Diode, Type 007, selected	Dana		211236
CR5	Diode, Type 007, selected	Dana		211236
CR6	Diode, Zener, 1N958B	01295	1N958B	220012
CR7	Diode, Type 007, selected	Dana		211236
CR8	Diode, Type 007, selected	Dana		211236
CR9	Diode, 1N662	01295	1N662	211083
CR10	Diode, 1N662	01295	1N662	211083
CR11	Diode, Zener, 1N961B	04713	1N961B	220004
CR12	Diode, Zener, 1N961B	04713	1N961B	220004
CR13	Diode, Type 007, selected	Dana		211236
CR14	Diode, Type 007, selected	Dana		211236
CR16	Diode, 1N662	01295	1N662	211083
CR17	Diode, 1N662	01295	1N662	211083
CR51	Transistor, Type 415, selected	Dana		200026
CR52	Transistor, Type 415, selected	Dana		200026
J1	Connector, receptacle, 15-pin	71785	DA-155-2	600063
K1	Relay, reed, 1250 ohms	09026	BR16-1250-B26-525	310011

PARTS LIST

Printed Circuit Board Assembly, Null Detector Isolator — Dana 400438 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
K2	Relay, reed, 1250 ohms	09026	BR16-1250-B26-525	310011
K3	Relay, reed, 1250 ohms	09026	BR16-1250-B26-525	310011
P1	Connector, plug, 15-pin	71785	DA-15P-6	600069
Q1	Transistor, 2N1304	01295	2N1304	201084
Q2	Transistor, Dual, selected	Dana	-	200028
Q3	Transistor, Type 016, selected	Dana	-	200040
Q4-Q5	Transistor, matched pair, Type 415	Dana	-	200024
Q6-Q7	Transistor, matched pair, Type 415	Dana	-	200024
Q8	Transistor, Type 012, selected	Dana	-	200022
Q9	Transistor, 2N3565	07263	2N3565	200043
Q10	Transistor, 2N3565	07263	2N3565	200043
Q11	Transistor, Type 012, selected	Dana	-	200022
Q12	Transistor, 2N3565	07263	2N3565	200043
Q13	Transistor, Type 014, selected	Dana	-	200035
Q14	Transistor, Type 009, selected		-	200011
Q16	Transistor, Type 016, selected	Dana	-	200040
Q17	Transistor, matched pair, Type 415	Dana	-	200024
Q19	Transistor, 2N3565	07263	2N3565	200043
Q20	Transistor, 2N3565	07263	2N3565	200043
Q21	Transistor, 2N3565	07263	2N3565	200043
Q22	Transistor, Type 012, selected	Dana	-	200022
Q23	Transistor, 2N3565	07263	2N3565	200043
Q24	Transistor, Type 014, selected	Dana	-	200035
Q25	Transistor, Type 014, selected	Dana	-	200035
Q40	Transistor, Type 016, selected	Dana	-	200040
R1	Resistor, Metal Film, 7.5k, 1/4w, 1%	07716	RN60B7501F	010079
R2	Resistor, Comp, 75 ohm, 1/4w, 5%	01121	CB-7505	000750
R3	Resistor, Variable, w-w, 200k	73490	62PR200K	040067
R4	Resistor, Metal Film, 60.4k, 1/4w, 1%	07716	RN60C6042F	010013
R5	Resistor, Metal Film, 60.4k, 1/4w, 1%	07716	RN60C6042F	010013
R6	Resistor, Comp, 6.2k, 1/4w, 5%	01121	CB-6225	000622
R7	Resistor, Comp, 560 ohm, 1/4w, 5%	01121	CB-5615	000561
R8	Resistor, Comp, 6.2k, 1/4w, 5%	01121	CB-6225	000622
R9	Resistor, Comp, 100 ohm, 1/4w, 5%	01121	CB-1015	000101

PARTS LIST

Printed Circuit Board Assembly, Null Detector Isolator — Dana 400438 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
R10	Resistor, Comp, 62 oh, 1/4w, 5%	01121	CB-6205	000620
R11	Resistor, Comp, 18k, 1/4w, 5%	01121	CB-1835	000183
R12	Resistor, Comp, 39 ohm, 1/4w, 5%	01121	CB-3905	000390
R13	Resistor, Metal Film, 200k, 1/4w, 1%	07716	RN60B2003F	010158
R14	Resistor, Variable, 2K	17826	35-2000	040041
R15	Resistor, Field Selected value	Dana		
R16	Resistor, Field Selected value	Dana		
R17	Resistor, Field Selected value	Dana	-	020124C
R18	Resistor, Variable, 1k	17826	20-1000	040033
R19	Resistor, Field Selected value	Dana		
R20	Resistor, Metal Film, 110 ohm, 1/4w, 1%	07716	RN60B1100F	010161
R21	Resistor, Metal Film, 50m-ohm, 1/2w, 1%	03888	HR70	010139
R22	Resistor, Variable, 20k, Bush mount	17826	30-20K	040023
R23	Resistor, Metal Film, 10k, 1/4w, 1%	07716	RN60B1002F	010060
R24	Resistor, Field Selected value	Dana	-	
R25	Resistor, Metal Film, 10M, 1/2w, 1%	03888	70-10M	010236
R26	Resistor, Field Selected value	Dana	-	
R27	Resistor, Metal Film, 10M, 1/2w, 1%	03888	70-10M	010236
R28	Resistor, Comp, 10K, 1/4w, 5%	01121	CB-1035	000103
R29	Resistor, Metal Film, 80.6K, 1/4w, 1%	07716	RN60B8062F	010077
R30	Resistor, Metal Film, 80.6K, 1/4w, 1%	07716	RN60B8062F	010077
R31	Resistor, Metal Film, 10k, 1/4w, 1%	07716	RN60B1002F	010060
R33	Resistor, Metal Film, 10k, 1/4w, 1%	07716	RN60B1002F	010060
R34	Resistor, Metal Film, 8.06k, 1/4w, 1%	07716	RN60B8061F	010080
R35	Resistor, Metal Film, 1.62k, 1/4w, 1%	07716	RN60B1621F	010009
R36	Resistor, Metal Film, 806k, 1/4w, .025%	07716	RN65D8063F	010165
R37	Resistor, Variable, wire-wound, 1k	17826	30-1k	040033
R38	Resistor, Field Selected value	Dana		
R39	Resistor, wire-wound, 10k, 3%	00213	100S	021154
R40	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R41	Resistor, Comp, 1k, 1/4w, 5%	01121	CB-1025	000102
R42	Resistor, Metal Film, 499 ohm, 1/4w, 1%	07716	RN60B	010027
R43	Resistor, Metal Film, 499 ohm, 1/4w, 1%	07716	RN60B	010027
R44	Resistor, Comp, 18k, 1/4w, 5%	01121	CB-1835	000183
R45	Resistor, Comp, 100 ohm, 1/4w, 5%	01121	CB-1015	000101
R46	Resistor, Comp, 10k, 1/4w, 5%	01121	CB-1035	000103

PARTS LIST

Printed Circuit Board Assembly, Null Detector Isolator — Dana 400438 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
R47	Resistor, Comp, 100k, 1/4w, 5%	01121	CB-1045	000104
R48	Resistor, Comp, 39 ohm, 1/4w, 5%	01121	CB-3905	000390
R49	Resistor, Metal Film, 18.2k, 1/4w, 1%	07716	RN60DT	010209
R50	Resistor, Metal Film, 4.02k, 1/4w, 1%	07716	RN60B4021F	010114
R51	Resistor, Metal Film, 422k, 1/4w, 1%	07716	RN60B4223F	010038
R52	Resistor, Comp, 1.5M-ohm, 1/4w, 5%	01121	CB-1555	000155
R53	Resistor, Comp, 1.5M-ohm, 1/4w, 5%	01121	CB-1555	000155
R54	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R55	Resistor, Metal Film, 1k, 1/4w, 1%	07716	RN60B1001F	011332
R56	Resistor, Metal Film, 1k, 1/4w, 1%	07716	RN60B1001F	011332
R57	Resistor, Comp, 360k, 1/4w, 5%	01121	CB-3645	000364
R59	Resistor, Comp, 1k, 1/4w, 5%	01121	CB-1025	000102
R60	Resistor, Metal Film, 10M-ohm, 1/2w, 1%	03888	70-10M	010236
R61	Resistor, Comp, 100k, 1/4w, 5%	01121	CB-1045	000104
R62	Resistor, Metal Film, 1.62k, 1/4w, 1%	07716	RN60B1621F	010009
R63	Resistor, Metal Film, 1.62k, 1/4w, 1%	07716	RN60B1621F	010009
R64	Resistor, Metal Film, 30.1k, 1/2w, 1%	07716	RN60B3012F	010019
R65	Resistor, Comp, 10k, 1/4w, 5%	01121	CB-1035	000103
R66	Resistor, Comp, 39 ohm, 1/4w, 5%	01121	CB-3905	000390
R67	Resistor, Comp, 10 ohm, 1/4w, 5%	01121	CB-1005	000100
R68	Resistor, Comp, 62 ohm, 1/4w, 5%	01121	CB-6205	000620
R69	Resistor, Comp, 220 ohm, 1/4w, 5%	01121	CB-2215	000221
R76	Resistor, Comp, 56k, 1/4w, 5%	01121	CB-5635	000563
R85	Resistor, Metal Film, 10k, 1/4w, 1%	07716	RN60B1002F	010060
R123	Resistor, Metal Film, 887k, 1/2w, 1%	07716	RN70D8873F	010164
R124	Resistor, Metal Film, 182k, 1/4w, 1%	07716	RN60D1823F	010208
R125	Resistor, Carbon, 10k, 1/4w, 5%	01121	CB-1035	000103
R126	Resistor, Field Selected value	Dana		

PARTS LIST

Printed Circuit Board Assembly, Internal Reference and Buffer — Dana 400370

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
C1	Capacitor, electrolytic, 10uF, 25V	56289	TE1204	111262
C2	Capacitor, Mylar, .0015uF, 10%,100V	14655	WMF1015Myl	121473
C4	Capacitor, Mylar, .047uF, 10%,100V	14655	WMF1547EMyl	121093
C5	Capacitor, electrolytic, 500uF, 50V	56289	TE1307	111097
C6	Capacitor, electrolytic, 50uF, 50V	56289	TE1307	111097
C7	Capacitor, Mylar, .047uF, 10%, 100V	14655	WMF1547EMyl	121093
C8	Capacitor, tanta., 22uF, 10%, 35V	05397	K22635K	110002
C9	Capacitor, ceramic disc, .001uF, 35V	00656	SCD3X5F	101174
CR1	Diode, Zener	04713	1/4M2.4AZS	221177
CR2	Assembly, bridge element pre-aged Diode	Dana	-	400017
CR6	Diode, 007, Selected	Dana	-	211236
CR7	Diode, Zener, 1N751	04713	1N751	220007
CR16	Diode, Zener, 1N967B	04713	1N967B	220015
CR22 thru CR24	Diode, SD4, Selected	Dana	-	210004
CR25	Diode, Zener, 1N961B	04713	1N961B	220004
CR26	Diode, Zener	04713	1/4M2.4AZ5	221177
CR27	Diode, Zener	04713	1/4M2.4AZ5	221177
K1	Relay, reed	09026	12H-1.6k63	311274
K2	Relay, reed	09026	12H-1.6k63	311274
K3	Relay, reed	09026	12H-1.6k63	311274
Q1	Transistor, 009	Dana	-	200011
Q2	Transistor, SS71032, selected	Dana	-	201285
Q4	Transistor, 014, selected	Dana	-	200035
Q5	Transistor, 014, selected	Dana	-	200035
Q6	Transistor, 2N3565	07263	2N3565	200043
Q7	Transistor, 014, selected	Dana	-	200035
Q8	Transistor, 2N3565	07263	2N3565	200043
Q9	Transistor, 2N3565	07263	2N3565	200043
Q10	Transistor, 2N3565	07263	2N3565	200043
Q11	Transistor, 009, selected	Dana	-	200011
Q12	Transistor, 2N1304	01295	2N1304	201084
Q13	Transistor, 009, selected	Dana	-	200011

PARTS LIST

Printed Circuit Board Assembly, Internal Reference and Buffer — Dana 400370
(Cont)

Reference Designator	Description	Manufacturers'		Dana
		FSC	Part No.	Part No.
Q14	Transistor, 2N3565	07263	2N3565	200043
Q15	Transistor, 2N3565	07263	2N3565	200043
Q16	Transistor, 012, selected	Dana	-	200022
Q17	Transistor, 2N3565	07263	2N3565	200043
Q18	Transistor, 2N1304	01295	2N1304	201084
Q19	Transistor, 014, selected	Dana	-	200035
Q20	Transistor, 009, selected	Dana	-	200011
R1	Resistor, Comp, 10 ohm, 1/4w, 5%	01121	CB-1005	000100
R2	Resistor, Comp, 10 ohm, 1/4w, 5%	01121	CB-1005	000100
R3	Resistor, Comp, 15k, 1/4w, 5%	01121	CB-1535	000153
R4	Resistor, Comp, 5.1k, 1/2w, 5%	01121	EB-5125	001283
R5	Resistor, Comp, 680 ohm, 1/4w, 5%	01121	CB-6815	000681
R6	Resistor, wire-wound, 9k, .01%	07088	EP21-9k	020050
R7	Resistor, Comp, 75 ohm, 1/4w, 5%	01121	CB-7505	000750
R8	Resistor, Comp, 680 ohm, 1/2w, 5%	01121	EB-6815	001674
R9	Resistor, Comp, 680 ohm, 1/2w, 5%	01121	EB-6815	001674
R10-11	Assembly, Bridge Element, pre-aged Resistor	Dana	-	400017
R13	Resistor, wire-wound, 1.3.k, .1%	07088	EP21-1.31k	021280
R14	Resistor, Metal Film, 301k	07716	RN60B3013F	010105
R15	Resistor, wire-wound, 11k, .01%	07088	EP21-11k	020020
R16	Resistor, Comp, 120 ohm, 1/4w, 5%	01121	CB-1215	000121
R17	Resistor, Variable, 20k	80294	3067-P-1-203	040003
R18	Resistor, Comp, 5.1k, 1/4w, 5%	01121	CB-5125	000512
R19	Resistor, Comp, 120 ohm, 1/4w, 5%	01121	CB-1215	000121
R20	Resistor, Comp, 6.8k, 1/4w, 5%	01121	CB-6825	000682
R21	Resistor, Comp, 15k, 1/4w, 5%	01121	CB-1535	000153
R22	Resistor, Comp, 120k, 1/4w, 5%	01121	CB-1245	000124
R23	Resistor, Variable, 10k	17826	20-10K	040001
R24	Resistor, Metal Film, 60.4K	07716	RN20X6042F	011284
R25	Resistor, Metal Film, 60.4K	07716	RN20X6042F	011284
R26	Resistor, Metal Film, 100 ohm, 1%	07716	RN20X1000F	011411
R27	Resistor, Metal Film, 100 ohm, 1%	07716	RN20X1000F	011411
R28	Resistor, Comp, 39 ohm, 1/2w, 5%	01121	RB-3905	001684
R29	Resistor, Comp, 22k, 1/4w, 5%	01121	CB-2235	000223
R30	Resistor, Comp, 6.8k, 1/4w, 5%	01121	CB-6825	000682

PARTS LIST

Printed Circuit Board Assembly, Internal Reference and Buffer — Dana 400370
(Cont)

Reference Designator	Description	Manufacturers'		Dana
		FSC	Part No.	Part No.
R31	Resistor, Comp, 15k, 1/4w, 5%	01121	CB-1535	000153
R32	Resistor, Comp, 5.1K, 1/4w, 5%	01121	CB-5125	000512
R33	Resistor, Comp, 51k, 1/4w, 5%	01121	CB-5135	000513
R34	Resistor, Metal Film, 40.2k,1/4w, 1%	07716	RN60B4022F	011252
R35	Resistor, Metal Film, 2.43k,1/4w, 1%	07716	RN60B2431F	010012
R36	Resistor, Comp, 120 ohm, 1/4w, 5%	01121	CB-1215	000121
R37	Resistor, Comp, 120k, 1/4w, 5%	01121	CB-1245	000124
R38	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R39	Resistor, Metal Film, 7.5k,1/4w,1%	07716	RN60B7501F	010079
R40	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R41	Resistor, Metal Film, 20k, 1/4w, 1%	07716	RN60B2431F	010059
R42	Resistor, Metal Film, 2.43k, 1/4w,1%	07716	RN60B2431F	010012
R43	Resistor, Comp, 5.6k, 1/4w, 5%	01121	CB-5625	000562
R44	Resistor, Comp, 10k, 1/4w, 5%	01121	CB-1035	000103
R45	Resistor, Comp, 47ohm, 1/2w, 5%	01121	EB-4705	001683
R46	Resistor, Comp, 22k, 1/4w, 5%	01121	CB-2235	000223
R47	Resistor, Metal Film, 7.5k, 1/4w, 1%	07716	RN60B7501F	010079
R49	Resistor, Comp, 1.2k, 1/4w, 5%	01121	CB-1225	000122
R50	Resistor, Comp, 22k, 1/4w, 5%	01121	CB-2235	000223
R52	Resistor, Comp, 240 ohm,1/4w,5%	01121	CB-2415	000241
R53	Resistor, Comp, 5.6k, 1/2w, 5%	01121	EB-5625	001293
R54	Resistor, Comp, 5.6k, 1/4w, 5%	01121	CB-5625	000562
R55	Resistor, Comp, 7.5k, 1/4w, 5%	01121	CB-7525	000752
R60	Resistor, Comp, 10k, 1/4w, 5%	01121	CB-1035	000103
R61	Resistor, Comp, 5.6k, 1/2w, 5%	01121	EB-5625	001293
R62	Resistor, Comp, 1.2k,1/4w, 5%	01121	CB-1225	000122
R64	Resistor, Comp, 1.2k, 1/4w, 5%	01121	CB-1225	000122
R65	Resistor, Comp, 2.2k, 1/2w, 5%	01121	EB-2225	001100
R67	Resistor, Comp, 39 ohm, 1/4w, 5%	01121	CB-3905	000390
R68	Resistor, Comp, 39 ohm, 1/4w, 5%	01121	CB-3905	000390
R69	Resistor, Comp, 3.3k, 1/4w, 5%	01121	CB-3325	000332
R70	Resistor, Comp, 3.3k, 1/4w, 5%	01121	CB-3325	000332
S1	Switch, pushbutton	02238	1PB5	000094

PARTS LIST

Printed Circuit Board Assembly, Program — Dana 400296

Reference Designator	Description	Manufacturers'		Dana
		FSC	Part No.	Part No.
C1	Capacitor, ceramic disc, 330pF, 100V	00656	SCD1X5F	101098
C2	Capacitor, Ceramic disc, 47pF, 100V	00656	N750-S1	101182
C3	Capacitor, polysty.film, .0015uF,10%, 100V	14655	WMF1D15Myl	121473
C4	Capacitor, polysty.film, .0068uF,10%, 100V	14655	WMF1D68Myl	121147
C5	Capacitor, polysty.film, .015uF, 10%, 100V	14655	WMF1S15ECD	121090
C6	Capacitor, polysty.film, .015uF, 10%, 100V	14655	WMF1S15ECD	121090
C7	Capacitor, electrolytic, 1 uF, 25V	56289	TE1200	111095
C8	Capacitor, polysty. film, .15 uF, 10%, 100V	14655	WMF1P15E	121394
C9	Capacitor, tantalum, 22uF, 20%, 35V	05397	K22C35K	110002
C10	Capacitor, polysty. film, .15 uF, 10%, 100V	14655	WMF1P153	121394
CR1 thru CR9	Diode, 1N662	07263	1N662	211083
CR15	Diode, 1N662	07263	1N662	211083
CR16	Diode, 1N662	07263	1N662	211083
CR17	Diode, 1N662	07263	1N662	211083
CR25	Diode, 1N662	07263	1N662	211083
CR36 thru CR47	Diode, 1N662	07263	1N662	211083
CR48	Diode, Zener, 1N961B	04713	1N961B	220004
CR49	Diode, 1N662	07263	1N662	211083
CR50	Diode, Zener, 1N751	04713	1N751	220007
CR51 thru CR54	Diode, 1N662	07263	1N662	211083
Q1	Transistor, 2N1304	01295	2N1304	201084
Q2	Transistor, 2N1304	01295	2N1304	201084
Q3	Transistor, 2N1304	01295	2N1304	201084
Q4	Transistor, 2N3646	07263	2N3646	200037

PARTS LIST

Printed Circuit Board Assembly, Program — Dana 400296 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
Q5	Transistor, 2N1304	01295	2N1304	201084
Q6	Transistor, 2N1304	01295	2N1304	201084
Q7	Transistor, 2N1304	01295	2N1304	201084
Q8	Transistor, Type 012, Select.	Dana	-	200022
Q9	Transistor, 2N1304	01295	2N1304	201084
Q10	Transistor, 2N1304	01295	2N1304	201084
Q11	Transistor, 2N1304	01295	2N1304	201084
Q12	Transistor, 2N1304	01295	2N1304	201084
Q13	Transistor, 2N3565	07263	2N3565	200043
Q14	Transistor, 2N1304	01295	2N1304	201084
R1	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
A-R1	Resistor, Comp, 4.7k, 1/2w, 5%	01121	EB-4725	001692
F-R1	Resistor, Comp, 2.7k, 1/2w, 5%	01121	EB-2725	001677
R2	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R3	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R4	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
A-R4	Resistor, Comp, 4.7k, 1/2w, 5%	01121	EB-4725	001692
F-R4	Resistor, Comp, 2.7k, 1/2w, 5%	01121	EB-2725	001677
R5	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R6	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R7	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R8	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R9	Resistor, Comp, 27k, 1/4w, 5%	01121	CB-2735	000273
R10	Resistor, Comp, 12k , 1/4w, 5%	01121	CB-1235	000123
A-R10	Resistor, Comp, 4.7k, 1/2w, 5%	01121	EB-4725	001692
R11	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
A-R11	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R12	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
H-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753
J-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753
K-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753
L-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753
M-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753
R13	Resistor, Comp, 27k, 1/4w, 5%	01121	CB-2735	000273
R14	Resistor, Comp, 1k, 1/4w, 5%	01121	CB-1025	000102
R15	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123

Printed Circuit Board Assembly, Program — Dana 400296 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
R16	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R17	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R18	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R19	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R20	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R21	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R22	Resistor, Comp, 330k, 1/4w, 5%	01121	CB-3345	000334
R24	Resistor, Comp, 2.2k, 1/2w, 5%	01121	EB-2225	001100
R24	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R25	Resistor, Comp, 2.2k, 1/2w, 5%	01121	EB-2225	001100
R26	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R40	Resistor, Comp, 330k, 1/4w, 5%	01121	CB-3345	000334
R41	Resistor, Comp, 33k, 1/4w, 5%	01121	CB-3335	000333
R42	Resistor, Comp, 10k, 1/4w, 5%	01121	CB-1035	000103
R43	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R44	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R45	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R46	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R47	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R49	Resistor, Comp, 3.6k, 1/4w, 5%	01121	CB-3625	000362
R50	Resistor, Comp, 2k, 1/2w, 5%	01121	EB-2025	001261
R51	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R52	Resistor, Comp, 1.2k, 1/4w, 5%	01121	CB-1225	000122
R53	Resistor, Comp, 510 ohm, 1/4w, 5%	01121	CB-5115	000511
R54	Resistor, Comp, 20k, 1/4w, 5%	01121	CB-2035	000203
R55	Resistor, Comp, 11k, 1/4w, 5%	01121	CB-1135	000113
R56	Resistor, Comp, 4.7k, 1/4w, 5%	01121	CB-4725	000472
R57	Resistor, Comp, 16k, 1/4w, 5%	01121	CB-1635	000163
R58	Resistor, Comp, 680 ohm, 1/4w, 5%	01121	CB-6815	000681
R59	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R60	Resistor, Comp, 47k, 1/4w, 5%	01121	CB-4735	000473
R61	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R62	Resistor, Comp, 27k, 1/4w, 5%	01121	CB-2735	000273

PARTS LIST

Printed Circuit Board Assembly, Readout — Dana 400467

Reference Designator	Description	Manufacturers'		Dana
		FSC	Part No.	Part No.
CR3 thru CR6	Diode, 1N662	04713	1N662	211083
Q5	Transistor, Type 014, selected	Dana	-	200035
R7	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R42	Resistor, Comp, 20k, 1w, 5%	01121	GB-2035	001698
R43	Resistor, Comp, 2M, 1/4w, 5%	01121	CB-2055	000205
XR7	Resistor, Comp, 15k, 1/4w, 5%	01121	CB-1535	000153
YY7	Resistor, Comp, 15k, 1/4w, 5%	01121	CB-1535	000153

PARTS LIST

Printed Circuit Board Assembly, Function Readout, Option H-1 — 400468

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
CR21	Diode, 1N662	07263	1N662	211083
CR23	Diode, 1N662	07263	1N662	211083
CR25	Diode, 1N662	07263	1N662	211083
CR27	Diode, 1N662	07263	1N662	211083
CR29	Diode, 1N662	07263	1N662	211083
CR30	Diode, 1N662	07263	1N662	211083
CR33 thru CR36	Diode, 1N662	07263	1N662	211083
CR39	Diode, 1N662	07263	1N662	211083
CR40	Diode, 1N662	07263	1N662	211083
CR41	Diode, 1N662	07263	1N662	211083
CR46 thru CR58	Diode, 1N662	07263	1N662	211083
CR63	Diode, 1N662	07263	1N662	211083
CR75	Diode, 1N662	07263	1N662	211083
CR77	Diode, 1N662	07263	1N662	211083
CR79	Diode, 1N662	07263	1N662	211083
CR80	Diode, 1N662	07263	1N662	211083
CR81	Diode, 1N662	07263	1N662	211083
CR89	Diode, 1N662	07263	1N662	211083
CR95	Diode, 1N662	07263	1N662	211083
CR96	Diode, 1N662	07263	1N662	211083
CR99	Diode, 1N662	07263	1N662	211083
CR101	Diode, 1N662	07263	1N662	211083
CR103	Diode, 1N662	07263	1N662	211083
CR109	Diode, 1N662	07263	1N662	211083

PARTS LIST

Printed Circuit Board Assembly, Auto Range — Dana 400297

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
C1	Capacitor, ceramic disc, 330 pF, 10%	00656	SCD1X5F	101098
CR1 thru CR12	Diode, 1N662	07263	1N662	211083
CR15	Diode, 1N662	07263	1N662	211083
CR16	Diode, 1N662	07263	1N662	211083
CR17	Diode, 1N662	07263	1N662	211083
CR25	Diode, 1N662	07263	1N662	211083
CR26	Diode, 1N662	07263	1N662	211083
CR36	Diode, 1N662	07263	1N662	211083
CR37	Diode, 1N662	07263	1N662	211083
CR38	Diode, 1N662	07263	1N662	211083
Q1	Transistor, 2N1304	01295	2N1304	201084
Q2	Transistor, 2N1304	01295	2N1304	201084
Q3	Transistor, 2N1304	01295	2N1304	201084
R1	Resistor, Comp, 3k, 1/2w, 5%	01121	EB-3025	001633
C-R1	Resistor, Comp, 8.2k, 1/4w, 5%	01121	CB-8225	000822
D-R1	Resistor, Comp, 2.7k, 1/2w, 5%	01121	EB-2725	001677
R2	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R3	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R4	Resistor, Comp, 3k, 1/2w, 5%	01121	EB-3025	001633
C-R4	Resistor, Comp, 8.2k, 1/4w, 5%	01121	CB-8225	000822
D-R4	Resistor, Comp, 2.7k, 1/2w, 5%	01121	EB-2725	001677
R5	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R6	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R7	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R8	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R9	Resistor, Comp, 27k, 1/4w, 5%	01121	CB-2735	000273
R10	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
L-R10	Resistor, Comp, 5.6k, 1/4w, 5%	01121	CB-5625	000562
R11	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R12	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
A-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753
B-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753
C-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753
D-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753

PARTS LIST

Printed Circuit Board Assembly, Auto Range — Dana 400297 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
E-R12	Resistor, Comp, 75k, 1/4w, 5%	01121	CB-7535	000753
R40	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R41	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R42	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243

PARTS LIST

Printed Circuit Board Assembly, Digit Readout, Basic — Dana 400463

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
CR3 thru CR6	Diode, 1N662	04713	1N662	211083
Q5	Transistor, Type 014, selected	Dana	-	200035
R7	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R-R7	Resistor, Comp, 15k, 1/4w, 5%	01121	CB-1535	000153
b-R7	Resistor, Comp, 15k, 1/4w, 5%	01121	CB-1535	000153
B-R7	Resistor, Comp, 15k, 1/4w, 5%	01121	CB-1535	000153
N-R7	Resistor, Comp, 15k, 1/4w, 5%	01121	CB-1535	000153
R40	Resistor, Comp, 20k, 1w, 5%	01121	GB-2035	001698
R41	Resistor, Comp, 2M, 1/4w, 5%	01121	CB-2055	000205
R42	Resistor, Comp, 2M, 1/4w, 5%	01121	CB-2055	000205
R43	Resistor, Comp, 20k, 1w, 5%	01121	GB-2035	001698

PARTS LIST

Printed Circuit Board Assembly, Printer Driver — Dana 400309

Reference Designator	Description	Manufacturers'		Dana
		FSC	Part No.	Part No.
CR1	Diode, 1N662	07263	1N662	211083
K1 thru K25	Relay, SPST	02116	260-1A-24	310013
Q1	Transistor, Type 014, selected	Dana	-	200035

PARTS LIST

Printed Circuit Board Assembly, Digit Readout, Option H-1 — Dana 400464

Reference Designator	Description	Manufacturers'		Dana
		FSC	Part No.	Part No.
CR21	Diode, 1N662	04713	1N662	211083
CR23	Diode, 1N662	04713	1N662	211083
CR25	Diode, 1N662	04713	1N662	211083
CR27	Diode, 1N662	04713	1N662	211083
CR29	Diode, 1N662	04713	1N662.	211083
CR30	Diode, 1N662	04713	1N662	211083
CR33 thru CR36	Diode, 1N662	04713	1N662	211083
CR39	Diode, 1N662	04713	1N662	211083
CR40	Diode, 1N662	04713	1N662	211083
CR41	Diode, 1N662	04713	1N662	211083
CR46 thru CR58	Diode, 1N662	04713	1N662	211083

PARTS LIST

Printed Circuit Board Assembly, Main Null Detector — Dana 400439

Reference Designator	Description	Manufacturers'		Dana
		FSC	Part No.	Part No.
C5	Capacitor, tantalum, 6.8uF,20%, 35V	05397	K6R8C35K	110001
C20	Capacitor, disc, 680 pF, 10%	00656	SCD2XSF	101099
C21	Capacitor, .001 uF, 100V	14655	WMF1D1	120005
C22	Capacitor, tantalum, 1uF, 35V	05397	K1C35K	110017
C23	Capacitor, .001 uF, 100V	14655	WMF1D1	120005
C24	Capacitor, .002 uF, 100V	14655	WMF1S22-EMYL	121468
C25	Capacitor, tantalum, 22uF, 20%, 35V	05397	K22635K	110002
CR19	Diode, 1N662	07263	1N662	211083
CR40	Diode, 1N662	07263	1N662	211083
CR41	Diode, 1N662	07263	1N662	211083
CR43	Diode, 1N662	07263	1N662	211083
CR45	Diode, 1N662	07263	1N662	211083
CR46	Diode, 1N662	07263	1N662	211083
CR47	Diode, 1N662	07263	1N662	211083
CR48	Diode, 1N662	07263	1N662	211083
CR49	Diode, 1N662	07263	1N662	211083
CR50	Diode, 1N662	07263	1N662	211083
CR53	Diode, 1N662	07263	1N662	211083
CR54	Diode, 1N662	07263	1N662	211083
CR55	Diode, 1N662	07263	1N662	211083
J1	Connector, receptacle, 15-pin	71785	DA15S-2	600063
P1	Connector, plug, 15-pin	71785	DA15P-6	600069
Q29	Transistor, 2N3646	07263	2N3646	200037
Q30	Transistor, 2N3646	07263	2N3646	200037
R58	Resistor, Comp, 20k-ohm, 1/4w, 5%	01121	CB-2035	000203
R79	Resistor, Comp, 1k-ohm, 1/4w, 5%	01121	CB-1025	000102
R80	Resistor, Comp, 4.7k, 1/4w, 5%	01121	CB-4725	000472
R81	Resistor, Comp, 1k-ohm, 1/4w, 5%	01121	CB-1025	000102
R82	Resistor, Comp, 200 ohm, 1/4w, 5%	01121	CB-2015	000201
R83	Resistor, Comp, 4.7k, 1/4w, 5%	01121	CB-4725	000472
R84	Resistor, Comp, 3.9k, 1/4w, 5%	01121	CB-3925	000392
R86	Resistor, Variable, wire-wound, 10k	80294	3067P-1-103	040005
R87	Resistor, Comp, 10k, 1/4w, 5%	01121	CB-1035	000103

Printed Circuit Board Assembly, Main Null Detector — Dana 400439 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
R98	Resistor, Comp, 6.8k, 1/4w, 5%	01121	CB-6825	000682
R100	Resistor, Comp, 7.5k, 1/4w, 5%	01121	CB-7525	000752
R101	Resistor, Comp, 100k, 1/4w, 5%	01121	CB-1045	000104
R102	Resistor, Comp, 2k, 1/4w, 5%	01121	CB-2025	000202
R103	Resistor, Comp, 100 ohm, 1/4w, 5%	01121	CB-1015	000101
R104	Resistor, Comp, 6.8k, 1/4w, 5%	01121	CB-6825	000682
R105	Resistor, Comp, 7.5k, 1/4w, 5%	01121	CB-7525	000752
R106	Resistor, Comp, 100k, 1/4w, 5%	01121	CB-1045	000104
R107	Resistor, Comp, 2k, 1/4w, 5%	01121	CB-2025	000202
R108	Resistor, Comp, 100 ohm, 1/4w, 5%	01121	CB-1015	000101
R109	Resistor, Comp, 6.8k, 1/4w, 5%	01121	CB-6825	000682
R110	Resistor, Comp, 7.5k, 1/4w, 5%	01121	CB-7525	000752
R111	Resistor, Comp, 100k, 1/4w, 5%	01121	CB-1045	000104
R112	Resistor, Comp, 2k, 1/4w, 5%	01121	CB-2025	000202
R113	Resistor, Comp, 100 ohm, 1/4w, 5%	01121	CB-1015	000101
R114	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R115	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R116	Resistor, Comp, 27k, 1/4w, 5%	01121	CB-2735	000273
R117	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R118	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R119	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R120	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R121	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R122	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123

Printed Circuit Assembly, 10,000 Decade - Dana 400258 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
C1	Capacitor, ceramic disc, 330pF, 10%	00656	SCD1X5F	101098
CR1 thru CR8	Diode, 1N662	07263	1N662	211083
CR25	Diode, 1N662	07263	1N662	211083
CR36	Diode, 1N662	07263	1N662	211083
CR37	Diode, 1N662	07263	1N662	211083
CR39 thru CR102	Diode, 1N662	07263	1N662	211083
	Set; selected resistor; wire-wound; .01%, 100k(4), 200,002 ohm (2), 180,000 ohm, .01%; (R17, R24, R32, R40, R48, R56, and R60)	Dana	020025B	020025B
Q1	Transistor, 2N1304	01295	2N1304	201084
Q2	Transistor, 2N1304	01295	2N1304	201084
Q4 thru Q15	Transistor, 2N1308 (selected)	01295	2N1308	200039
R1	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R2	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R3	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R4	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R5	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R6	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R7	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R8	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R9	Resistor, Comp, 27k, 1/4w, 5%	01121	CB-2735	000273
R14	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R15	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R16	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R17	(Part of 020025B, see top of list)			
R18	Resistor, Comp, 300k, 1/w, 5%	01121	CB-3045	000304
R19	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R20	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R21	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R22	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243

PARTS LIST

Printed Circuit Board Assembly, 10,000 Decade — Dana 400258 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
R23	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R24	(Part of 020025B, see top of list)			
R25	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R26	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R27	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R28	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R29	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R30	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R31	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R32	(Part of 020025B, see top of list)			
R33	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R34	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R35	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R36	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R37	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R38	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R39	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R40	(Part of 020025B, see top of list)			
R41	Resistor, Comp, 300k,1/4w, 5%	01121	CB-3045	000304
R42	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R43	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R44	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R45	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R46	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R47	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R48	(Part of 020025B, see top of list)			
R49	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R50	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R51	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R52	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R53	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R54	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R55	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R56	(Part of 020025B, see top of list)			
R57	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R58	Resistor, Comp, 39, 1/4w, 5%	01121	CB-3935	000393

PARTS LIST

Printed Circuit Board Assembly, 10,000 Decade — Dana 400258 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
R59 R60	Resistor, Comp, 39k, 1/4w, 5% (Part of 020025B, see top of list)	01121	CB-3935	000393

PARTS LIST

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
C1	Capacitor, ceramic disc, 330pF, 10%	00656	SCD1XSF	101098
CR1 thru CR7	Diode, 1N662	07263	1N662	211083
CR25	Diode, 1N662	07263	1N662	211083
CR36	Diode, 1N662	07263	1N662	211083
CR37 thru CR94	Diode, 1N662	07263	1N662	211083
	Set; selected resistor, wire-wound; 100k(4), 180k, 200k; (R16, R24, R32, R40, R48, and R52)	Dana	020026	020026
Q1	Transistor, 2N1304	01295	2N1304	201084
Q2	Transistor, 2N1304	01295	2N1304	201084
Q3	Transistor, 2N1304	01295	2N1304	201084
Q4 thru Q13	Transistor, 2N1308	01295	2N1308	201438
R1	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R2	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R3	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R4	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R5	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R6	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R7	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
E-R7	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
A-R7	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R8	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R9	Resistor, Comp, 27k, 1/4w, 5%	01121	CB-2735	000273
R10	Resistor, Comp, 12k, 1/4w, 5%	01121	CB-1235	000123
R11	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R12	Resistor, Comp, 150k, 1/4w, 5%	01121	CB-1545	000154
R13	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R14	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R15	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R16	(Part of 020026, see top of list)			
R17	Resistor, Comp, 200, 1/4w, 5%	01121	CB-3045	000304

PARTS LIST

Printed Circuit Board Assembly, 1000 Decade — Dana 400435 (Cont)

Reference Designator	Description	Manufacturers' FSC	Manufacturers' Part No.	Dana Part No.
R18	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R19	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R20	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R21	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R22	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R23	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R24	(Part of 020026, see top of list)			
R25	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R26	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R27	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R28	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R29	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R30	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R31	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R32	(Part of 020026, see top of list)			
R33	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R34	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R35	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R36	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R37	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R38	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R39	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R40	(Part of 020026, see top of list)			
R41	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R42	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R43	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R44	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R45	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R46	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243
R47	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R48	(Part of 020026, see top of list)			
R49	Resistor, Comp, 300k, 1/4w, 5%	01121	CB-3045	000304
R50	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R51	Resistor, Comp, 39k, 1/4w, 5%	01121	CB-3935	000393
R52	(Part of 020026, see top of list)			
R53	Resistor, Comp, 24k, 1/4w, 5%	01121	CB-2435	000243

PARTS LIST

PC BOARD ASSEMBLY INTERNAL REFERENCE AND BUFFER 400370

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
C1	111262	CAP	ELECT	10 MFD 25 V 20%	SPRAGUE	TE1204
C2	121473	CAP	MYLAR	.0015 MFD 100 V 10%	CDE	WMF1S47
C4	121093	CAP	MYLAR	.047 MFD 100 V 10%	CDE	WMF1S47
C5	111262	CAP	ELECT	10 MFD 25 V 20%	SPRAGUE	TE1204
C6	111097	CAP	ELECT	50 MFD 50 V 20%	SPRAGUE	TE1307
C7	121093	CAP	MYLAR	.047 MFD 100 V 10%	CDE	WMF1S47
C8	110002	CAP	TANTA	22 MFD 35 V 10%	KEMET	K22C35K
C9	101174	CAP	CERAM	.001 MFD 500 V 10%	AEROVOX	SCD3X5F
CR1	221177	DIODE	SILICO ZENER	1/4 W	MOTOROLA	M.2.4A25
CR2	400017					
CR6	211236					
CR7	220007	DIODE	SILICO ZENER 1N751		MOTOROLA	1N751
CR16	220015	DIODE	SILICO ZENER 1N967B		MOTOROLA	1N967B
CR22	210004	DIODE	SILICO SD-4			
CR23	210004	DIODE	SILICO SD-4			
CR24	210004	DIODE	SILICO SD-4			
CR25	220004	DIODE	SILICO ZENER 1N961B		MOTOROLA	1N961B
CR26	221177	DIODE	SILICO ZENER	1/4 W	MOTOROLA	M.2.4A25
CR27	221177	DIODE	SILICO ZENER	1/4 W	MOTOROLA	M.2.4A25
F1	920039	FUSE	.1 A		DANA	3AG1/10AS8
K1	311274	RELAY	DC 2 PDT 26V		BABCOCK	BR12H-1.6KC3
K2	311274	RELAY	DC 2 PDT 26V		BABCOCK	BR12H-1.6KC3
K3	311274	RELAY	DC 2 PDT 26V		BABCOCK	BR12H-1.6KC3
Q1	200011	TRANS	SILICO PNP 009		DANA	200011
Q2	201285					
Q4	200035	TRANS	SILICO NPN 014		DANA	200035
Q5	200035	TRANS	SILICO NPN 014		DANA	200035
Q6	200043	TRANS	SILICO NPN 2N3565		FAIRCHILD	2N3565
Q7	200035	TRANS	SILICO NPN 014		DANA	200035
Q8	200043	TRANS	SILICO NPN 2N3565		FAIRCHILD	2N3565
Q9	200043	TRANS	SILICO NPN 2N3565		FAIRCHILD	2N3565
Q10	200043	TRANS	SILICO NPN 2N3565		FAIRCHILD	2N3565
Q11	200011	TRANS	SILICO PNP 009		DANA	200011
Q12	201084	TRANS	GERMAN PNP 2N1304		TI	2N1304
Q13	200011	TRANS	SILICO PNP 009		DANA	200011
Q14	200043	TRANS	SILICO NPN 2N3565		FAIRCHILD	2N3565
Q15	200043	TRANS	SILICO NPN 2N3565		FAIRCHILD	2N3565
Q16	200022	TRANS	SILICO PNP 012		DANA	200022
Q17	200043	TRANS	SILICO NPN 2N3565		FAIRCHILD	2N3565
Q18	201084	TRANS	GERMAN PNP 2N1304		TI	2N1304

PARTS LIST

PC BOARD ASSEMBLY INTERNAL REFERENCE AND BUFFER 400370

REF DES	DANA P/N	PART	TYPE	DESCRIPTION				MANUFAC	MANUFAC P/N
Q19	200035	TRANS	SILICO NPN	014				DANA	200035
Q20	200011	TRANS	SILICO PNP	009				DANA	200011
R1	000100	RES	CARBON	10	OHM	5%	1/4 W	OHMITE	RC07GF100J
R2	000100	RES	CARBON	10	OHM	5%	1/4 W	OHMITE	RC07GF100J
R3	000153	RES	CARBON	15	K	5%	1/4 W	OHMITE	RC07GF153J
R4	001283	RES	CARBON	5.1	K	5%	1/2 W	OHMITE	RC20GF512J
R5	000681	RES	CARBON	680	OHM	5%	1/4 W	OHMITE	RC07GF681J
R6	021280	RES	WW	1.31	K	0.1%	1/4 W	JORDAN	J-12
R7	000750	RES	CARBON	75	OHM	5%	1/4 W	OHMITE	RC07GF750J
R8	001674	RES	CARBON	680	OHM	5%	1/2 W	OHMITE	RC20GF681J
R9	001674	RES	CARBON	680	OHM	5%	1/2 W	OHMITE	RC20GF681J
R10	400017								
R11	400017								
R13	021280	RES	WW	1.31	K	0.1%	1/4 W	JORDAN	J-12
R14	010105	RES	METAL	301	K	1%	1/4 W	ELECTRA	RN60D3013F
R15	020020	RES	WW	11	K	.01%	1/4 W	JORDAN	J-12
R16	000121	RES	CARBON	120	OHM	5%	1/4 W	OHMITE	RC07GF121J
R17	040003	RES	VARI	20	K	10%	1/2 W	BOURNS	3067-P-1-203
R18	000512	RES	CARBON	5.1	K	5%	1/4 W	OHMITE	RC07GF512J
R19	000121	RES	CARBON	120	OHM	5%	1/4 W	OHMITE	RC07GF121J
R20	000682	RES	CARBON	6.8	K	5%	1/4 W	OHMITE	RC07GF682J
R21	000153	RES	CARBON	15	K	5%	1/4 W	OHMITE	RC07GF153J
R22	000124	RES	CARBON	120	K	5%	1/4 W	OHMITE	RC07GF124J
R23	040001	RES	VARI	100	K	10%	1 W	TECHNO	20
R24	011284	RES	METAL	60.4	K	1%	1/2 W	IRC	RN20X6042F
R25	011284	RES	METAL	60.4	K	1%	1/2 W	IRC	RN20X6042F
R26	011411	RES	METAL	100	OHM	1%	1/4 W	IRC	RN20X1000F
R27	011411	RES	METAL	100	OHM	1%	1/4 W	IRC	RN20X1000F
R28	001684	RES	CARBON	39	OHM	5%	1/2 W	OHMITE	RC20GF390J
R29	000223	RES	CARBON	22	K	5%	1/4 W	OHMITE	RC07GF223J
R30	000682	RES	CARBON	6.8	K	5%	1/4 W	OHMITE	RC07GF682J
R31	000153	RES	CARBON	15	K	5%	1/4 W	OHMITE	RC07GF153J
R32	000512	RES	CARBON	5.1	K	5%	1/4 W	OHMITE	RC07GF512J
R33	000513	RES	CARBON	51	K	5%	1/4 W	OHMITE	RC07GF513J
R34	001125								
R35	010012	RES	METAL	2.43	K	1%	1/4 W	ELECTRA	RN60D2431F
R36	000121	RES	CARBON	120	OHM	5%	1/4 W	OHMITE	RC07GF121J
R37	000124	RES	CARBON	120	K	5%	1/4 W	OHMITE	RC07GF124J
R38	000123	RES	CARBON	12	K	5%	1/4 W	OHMITE	RC07GF123J

PARTS LIST

PC BOARD ASSEMBLY INTERNAL REFERENCE AND BUFFER 400470

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
R39	010079	RES	METAL	7.5 K	1%	1/4 W	ELECTRA	RN60D7501F
R40	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R41	010059	RES	METAL	20 K	1%	1/4 W	ELECTRA	RN60D2002F
R42	010012	RES	METAL	2.43 K	1%	1/4 W	ELECTRA	RN60D2431F
R43	000562	RES	CARBON	5.6 K	5%	1/4 W	OHMITE	RC07GF562J
R44	000103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R45	001683	RES	CARBON	47 OHM	5%	1/2 W	OHMITE	RC20GF470J
R46	000223	RES	CARBON	22 K	5%	1/4 W	OHMITE	RC07GF223J
R47	010076							
R49	000122	RES	CARBON	1.2 K	5%	1/4 W	OHMITE	RC07GF122J
R50	000223	RES	CARBON	22 K	5%	1/4 W	OHMITE	RC07GF223J
R52	000241	RES	CARBON	240 OHM	5%	1/4 W	OHMITE	RC07GF241J
R53	001293	RES	CARBON	5.6 K	5%	1/2 W	OHMITE	RC20GF562J
R54	900562							
R55	000752	RES	CARBON	7.5 K	5%	1/4 W	OHMITE	RC07GF752J
R60	311274	RELAY	DC	2 PDT	26V		BABCOCK	BR12H-1.6KC3
R61	001293	RES	CARBON	5.6 K	5%	1/2 W	OHMITE	RC20GF562J
R62	000122	RES	CARBON	1.2 K	5%	1/4 W	OHMITE	RC07GF122J
R64	000122	RES	CARBON	1.2 K	5%	1/4 W	OHMITE	RC07GF122J
R65	001100	RES	CARBON	2.2 K	5%	1/2 W	OHMITE	RC20GF222J
R66	000390	RES	CARBON	39 OHM	5%	1/4 W	OHMITE	RC07GF390J
R68	000390	RES	CARBON	39 OHM	5%	1/4 W	OHMITE	RC07GF390J
R69	000332	RES	CARBON	3.3 K	5%	1/4 W	OHMITE	RC07GF332J
R70	000332	RES	CARBON	3.3 K	5%	1/4 W	OHMITE	RC07GF332J
S1	600094							

PCB ASSEMBLY MAIN NULL DETECTOR 400439

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
C5	110001	CAP	TANTA	6.8 MFD 35 V 10%	KEMET	K6R8C35K
C20	101099	CAP	CERAM	680 PFD 500 V 10%	AEROVOX	SCD2X5F
C21	120005	CAP	MYLAR	.001 MFD 100 V 10%		WMF1D1
C22	110017	CAP	TANTA	1 MFD 35 V 10%	KEMET	K1C35K
C23	120005	CAP	MYLAR	.001 MFD 100 V 10%		WMF1D1
C24	121468	CAP	MYLAR	.022 MFD 100 V 10%	CDE	WMF1S22
C25	110002	CAP	TANTA	22 MFD 35 V 10%	KEMET	K22C35K
CR19	211083	DIODE	SILICO	018	DANA	211083
CR40	211083	DIODE	SILICO	018	DANA	211083
CR41	211083	DIODE	SILICO	018	DANA	211083
CR43	211083	DIODE	SILICO	018	DANA	211083
CR45	211083	DIODE	SILICO	018	DANA	211083
CR46	211083	DIODE	SILICO	018	DANA	211083
CR47	211083	DIODE	SILICO	018	DANA	211083
CR48	211083	DIODE	SILICO	018	DANA	211083
CR49	211083	DIODE	SILICO	018	DANA	211083
CR50	211083	DIODE	SILICO	018	DANA	211083
CR53	211083	DIODE	SILICO	018	DANA	211083
CR54	211083	DIODE	SILICO	018	DANA	211083
CR55	211083	DIODE	SILICO	018	DANA	211083
J1	600063	CONN	15 S		CINCH	DA15S2
P1	600069	CONN	15 P		CINCH	2311512121
Q29	200037	TRANS	SILICO NPN	2N3646	FAIRCHILD	2N3646
Q30	200037	TRANS	SILICO NPN	2N3646	FAIRCHILD	2N3646
R58	000203	RES	CARBON	20 K 5% 1/4 W	OHMITE	RC07GF203J
R79	000102	RES	CARBON	1 K 5% 1/4 W	OHMITE	RC07GF102J
R80	000472	RES	CARBON	4.7 K 5% 1/4 W	OHMITE	RC07GF472J
R81	000102	RES	CARBON	1 K 5% 1/4 W	OHMITE	RC07GF102J
R82	000201	RES	CARBON	200 OHM 5% 1/4 W	OHMITE	RC07GF201J
R83	000472	RES	CARBON	4.7 K 5% 1/4 W	OHMITE	RC07GF472J
R84	000392	RES	CARBON	0003.9 K 5% 1/4 W	OHMITE	RC07GF392J
R86	040005	RES	VARI	10 K 10% 1/2 W	BOURNS	3067-P-1-103
R87	000103	RES	CARBON	10 K 5% 1/4 W	OHMITE	RC07GF103J
R98	000682	RES	CARBON	6.8 K 5% 1/4 W	OHMITE	RC07GF682J
R100	000752	RES	CARBON	7.5 K 5% 1/4 W	OHMITE	RC07GF752J
R101	000104	RES	CARBON	100 K 5% 1/4 W	OHMITE	RC07GF104J
R102	000202	RES	CARBON	2 K 5% 1/4 W	OHMITE	RC07GF202J
R103	000101	RES	CARBON	100 OHM 5% 1/4 W	OHMITE	RC07GF101J
R104	000682	RES	CARBON	6.8 K 5% 1/4 W	OHMITE	RC07GF682J
R105	000752	RES	CARBON	7.5 K 5% 1/4 W	OHMITE	RC07GF752J

PCB ASSEMBLY MAIN NULL DETECTOR 400439

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION		MANUFAC	MANUFAC P/N
R106	CC0104	RES	CARBCN	100 K	5%	1/4 W OHMITE	RC07GF104J
R107	000202	RES	CARBCN	2 K	5%	1/4 W OHMITE	RC07GF202J
R108	000101	RES	CARBCN	100 OHM	5%	1/4 W OHMITE	RC07GF101J
R109	C00682	RES	CARBON	6.8 K	5%	1/4 W OHMITE	RC07GF682J
R110	C00752	RES	CARBCN	7.5 K	5%	1/4 W OHMITE	RC07GF752J
R111	000104	RES	CARBCN	100 K	5%	1/4 W OHMITE	RC07GF104J
R112	C00202	RES	CARBON	2 K	5%	1/4 W OHMITE	RC07GF202J
R113	C00101	RES	CARBCN	100 OHM	5%	1/4 W OHMITE	RC07GF101J
R114	000123	RES	CARBCN	12 K	5%	1/4 W OHMITE	RC07GF123J
R115	000123	RES	CARBCN	12 K	5%	1/4 W OHMITE	RC07GF123J
R116	C00273	RES	CARBON	27 K	5%	1/4 W OHMITE	RC07GF273J
R117	CC0154	RES	CARBON	150 K	5%	1/4 W OHMITE	RC07GF154J
R118	C00243	RES	CARBON	24 K	5%	1/4 W OHMITE	RC07GF243J
R119	000123	RES	CARBON	12 K	5%	1/4 W OHMITE	RC07GF123J
R120	C00243	RES	CARBCN	24 K	5%	1/4 W OHMITE	RC07GF243J
R121	000154	RES	CARBCN	150 K	5%	1/4 W OHMITE	RC07GF154J
R122	000123	RES	CARBON	12 K	5%	1/4 W OHMITE	RC07GF123J

PCB ASSEMBLY NULL DETECTOR ISOLATOR 400438

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
C1	110006	CAP	TANTA	100 MFD 10 V	10% KEMET	K100C10K
C2	120049	CAP	MYLAR	.15 MFD 200 V	10% VEDCO	17W
C3	121C92	CAP	MYLAR	.0022 MFD 100 V	10% CDE	WMF1D22
C4	101174	CAP	CERAM	.001 MFD 500 V	10% AEROVOX	SCD3X5F
C6	120C04	CAP	POLYS	.001 MFD 500 V	5% CRL	CPR-1000J
C7	110001	CAP	TANTA	6.8 MFD 35 V	10% KEMET	K6R8C35K
C8	120034	CAP	POLYS	100 PFD 500 V	5% CRL	CPR-100J
C9	110C02	CAP	TANTA	22 MFD 35 V	10% KEMET	K22C35K
C10	120048	CAP	MYLAR	.068 MFD 200 V	10% VEDCO	17W
C11	110C06	CAP	TANTA	100 MFD 10 V	10% KEMET	K100C10K
C12	121092	CAP	MYLAR	.0022 MFD 100 V	10% CDE	WMF1D22
C13	121393	CAP	MYLAR	.22 MFD 100 V	10% CDE	WMF1P22
C14	110002	CAP	TANTA	22 MFD 35 V	10% KEMET	K22C35K
C15	120004	CAP	POLYS	.001 MFD 500 V	5% CRL	CPR-1000J
C16	121147	CAP	MYLAR	.0068 MFD 100 V	10% CDE	WMF1D68
C17	110C02	CAP	TANTA	22 MFD 35 V	10% KEMET	K22C35K
CR1	211083	DIODE	SILICO	018	DANA	211083
CR2	210083					
CR3	211C83	DIODE	SILICO	018	DANA	211083
CR4	211236					
CR5	211236					
CR6	220012	DIODE	SILICO ZENER	1N958B	MOTOROLA	1N958B
CR7	211236					
CR8	211236					
CR9	211083	DIODE	SILICO	018	DANA	211083
CR10	211083	DIODE	SILICO	018	DANA	211083
CR11	220C04	DIODE	SILICO ZENER	1N961B	MOTOROLA	1N961B
CR12	220C04	DIODE	SILICO ZENER	1N961B	MOTOROLA	1N961B
CR13	211236					
CR14	211236					
CR16	211C83	DIODE	SILICO	018	DANA	211083
CR17	211C83	DIODE	SILICO	018	DANA	211083
CR51	200026					
CR52	200026					
J1	600063	CONN	15 S		CINCH	DA15S2
K1	310C11	RELAY	DC	2 PDT 26V	BABCOCK	BR16-1250B26S2
K2	310C11	RELAY	DC	2 PDT 26V	BABCOCK	BR16-1250B26S2
K3	310011	RELAY	DC	2 PDT 26V	BABCOCK	BR16-1250B26S2
P1	600069	CONN	15 P		CINCH	2311512121
Q1	201C84	TRANS	GERMAN PNP	2N1304	TI	2N1304

PCB ASSEMBLY NULL DETECTOR ISOLATOR 400438

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
Q2	200028					
Q3	200040	TRANS	SILICO NPN	016	DANA	200040
Q4	200024	TRANS	SILICO NPN DUAL	2N3707	DANA	200024
Q5	200024	TRANS	SILICO NPN DUAL	2N3707	DANA	200024
Q6	200024	TRANS	SILICO NPN DUAL	2N3707	DANA	200024
Q7	200024	TRANS	SILICO NPN DUAL	2N3707	DANA	200024
Q8	200022	TRANS	SILICO PNP	012	DANA	200022
Q9	200043	TRANS	SILICO NPN	2N3565	FAIRCHILD	2N3565
Q10	200043	TRANS	SILICO NPN	2N3565	FAIRCHILD	2N3565
Q11	200022	TRANS	SILICO PNP	012	DANA	200022
Q12	200043	TRANS	SILICO NPN	2N3565	FAIRCHILD	2N3565
Q13	200035	TRANS	SILICO NPN	014	DANA	200035
Q14	200011	TRANS	SILICO PNP	009	DANA	200011
Q16	200040	TRANS	SILICO NPN	016	DANA	200040
Q17	200024	TRANS	SILICO NPN DUAL	2N3707	DANA	200024
Q19	200043	TRANS	SILICO NPN	2N3565	FAIRCHILD	2N3565
Q20	200043	TRANS	SILICO NPN	2N3565	FAIRCHILD	2N3565
Q21	200043	TRANS	SILICO NPN	2N3565	FAIRCHILD	2N3565
Q22	200022	TRANS	SILICO PNP	012	DANA	200022
Q23	200043	TRANS	SILICO NPN	2N3565	FAIRCHILD	2N3565
Q24	200035	TRANS	SILICO NPN	014	DANA	200035
Q25	200035	TRANS	SILICO NPN	014	DANA	200035
Q40	200040	TRANS	SILICO NPN	016	DANA	200040
R1	010079	RES	METAL	7.5 K 1% 1/4 W	ELECTRA	RN60D7501F
R2	000750	RES	CARBON	75 OHM 5% 1/4 W	OHMITE	RC07GF750J
R3	040067	RES	VARI	200 K 10% 1/4 W	BECKMAN	62PR200K
R4	010013	RES	METAL	60.4 K 1% 1/4 W	ELECTRA	RN60C6042F
R5	010013	RES	METAL	60.4 K 1% 1/4 W	ELECTRA	RN60C6042F
R6	000622	RES	CARBON	6.2 K 5% 1/4 W	OHMITE	RC07GF622J
R7	000561	RES	CARBON	560 OHM 5% 1/4 W	OHMITE	RC07GF561J
R8	000622	RES	CARBON	6.2 K 5% 1/4 W	OHMITE	RC07GF622J
R9	000101	RES	CARBON	100 OHM 5% 1/4 W	OHMITE	RC07GF101J
R10	000620	RES	CARBON	62 OHM 5% 1/4 W	OHMITE	RC07GF620J
R11	000183	RES	CARBON	18 K 5% 1/4 W	OHMITE	RC07GF183J
R12	000390	RES	CARBON	39 OHM 5% 1/4 W	OHMITE	RC07GF390J
R13	010158	RES	METAL	200 K 1% 1/4 W	ELECTRA	RN60D2003F
R14	040041	RES	VARI	2 K 10% 1 W	TECHNO	35
R15	FSV					
R16	FSV					
R17	020124	RES	WW	9 M .02K ,60 W		

PCB ASSEMBLY NULL DETECTOR ISOLATOR 400438

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
R18	040033							
R19	FSV							
R20	010161	RES	METAL	110	OHM	1% 1/4 W	ELECTRA	RN60D1100F
R21	010139	RES	METAL	50	M	2% 1/4 W	PYROFILM	PFR6627
R22	040023	RES	VARI	20	K	10% 1 W	TECHNO	30
R23	010060	RES	METAL	10	K	1% 1/4 W	ELECTRA	RN60D1002F
R24	FSV							
R25	010236	RES	WW	10	MEG	1% 1 W	PME	PME70T2
R26	FSV							
R27	010236	RES	WW	10	MEG	1% 1 W	PME	PME70T2
R28	C00103	RES	CARBON	10	K	5% 1/4 W	OHMITE	RC07GF103J
R29	010077	RES	METAL	80.6	K	1% 1/4 W	ELECTRA	RN60D8062F
R30	010077	RES	METAL	80.6	K	1% 1/4 W	ELECTRA	RN60D8062F
R31	010060	RES	METAL	10	K	1% 1/4 W	ELECTRA	RN60D1002F
R33	010060	RES	METAL	10	K	1% 1/4 W	ELECTRA	RN60D1002F
R34	010080	RES	METAL	8.06	K	1% 1/4 W	ELECTRA	RN60D8061F
R35	0100C9	RES	METAL	1.62	K	1% 1/4 W	ELECTRA	RN60B1621F
R36	010165	RES	METAL	806	K	1% 1/2 W	ELECTRA	RN65D8063F
R37	040033							
R38	FSV							
R39	021154	RES	WW	10	K	3% 1/4 W	C-F	C-FM20
R40	000154	RES	CARBON	150	K	5% 1/4 W	OHMITE	RC07GF154J
R41	C00102	RES	CARBON	1	K	5% 1/4 W	OHMITE	RC07GF102J
R42	010027	RES	METAL	499	OHM	1% 1/4 W	ELECTRA	RN60D4990F
R43	010027	RES	METAL	499	OHM	1% 1/4 W	ELECTRA	RN60D4990F
R44	000183	RES	CARBON	18	K	5% 1/4 W	OHMITE	RC07GF183J
R45	C00101	RES	CARBON	100	OHM	5% 1/4 W	OHMITE	RC07GF101J
R46	C00103	RES	CARBON	10	K	5% 1/4 W	OHMITE	RC07GF103J
R47	C00104	RES	CARBON	100	K	5% 1/4 W	OHMITE	RC07GF104J
R48	CC0390	RES	CARBON	39	OHM	5% 1/4 W	OHMITE	RC07GF390J
R49	0102C9	RES	METAL	18.2	K	1% 1/4 W	ELECTRA	RN60D1822F
R50	010114	RES	METAL	4.02	K	1% 1/4 W	ELECTRA	RN60D4021F
R51	010038	RES	METAL	422	K	1% 1/4 W	ELECTRA	RN60D4223F
R52	000155	RES	CARBON	1.5	M	5% 1/4 W	OHMITE	RC07GF155J
R53	000155	RES	CARBON	1.5	M	5% 1/4 W	OHMITE	RC07GF155J
R54	000393	RES	CARBON	39	K	5% 1/4 W	OHMITE	RC07GF393J
R55	011332	RES	METAL	1	K	1% 1/4 W	ELECTRA	RN60D1001F
R56	011332	RES	METAL	1	K	1% 1/4 W	ELECTRA	RN60D1001F
R57	CC0364	RES	CARBON	360	K	5% 1/4 W	OHMITE	RC07GF364J
R5	CC0102	RES	CARBON	1	K	5% 1/4 W	OHMITE	RC07GF102J

PCB ASSEMBLY NULL DETECTOR ISOLATOR 400438

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
R60	010236	RES	WW	10 MEG	1%	1 W	PME	PME70T2
R61	000104	RES	CARBON	100 K	5%	1/4 W	OHMITE	RC07GF104J
R62	010009	RES	METAL	1.62 K	1%	1/4 W	ELECTRA	RN60B1621F
R63	010009	RES	METAL	1.62 K	1%	1/4 W	ELECTRA	RN60B1621F
R64	010019	RES	METAL	30.1 K	1%	1/4 W	ELECTRA	RN60B3012F
R65	CC0103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R66	CC0390	RES	CARBON	39 OHM	5%	1/4 W	OHMITE	RC07GF390J
R67	CC0100	RES	CARBON	10 OHM	5%	1/4 W	OHMITE	RC07GF100J
R68	CC0620	RES	CARBON	62 OHM	5%	1/4 W	OHMITE	RC07GF620J
R69	CC0221	RES	CARBON	220 OHM	5%	1/4 W	OHMITE	RC07GF221J
R76	CC0563	RES	CARBON	56 K	5%	1/4 W	OHMITE	RC07GF563J
R85	010060	RES	METAL	10 K	1%	1/4 W	ELECTRA	RN60D1002F
R123	010164	RES	METAL	887 K	1%	1 W	ELECTRA	RN70D8873F
R124	010208	RES	METAL	182 K	1%	1/4 W	ELECTRA	RN60D1823F
R125	CC0103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R126	FSV							

PC BOARD ASSEMBLY 10000 DECADE 5 DIGIT 400258

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
CR1 THRU	211083	DIODE	SILICO	018	DANA	211083
CR8	211083	DIODE	SILICO	018	DANA	211083
CR25	211083	DIODE	SILICO	018	DANA	211083
CR36	211083	DIODE	SILICO	018	DANA	211083
CR37	211083	DIODE	SILICO	018	DANA	211083
CR39 THRU	211083	DIODE	SILICO	018	DANA	211083
CR102	211083	DIODE	SILICO	018	DANA	211083
Q1	201084					
Q2	201084					
Q4 THRU	200060					
R1	000123	RES	CARBON	12 K 5% 1/4 W	OHMITE	RC07GF123J
R2	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R3	000154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R4	000123	RES	CARBON	12 K 5% 1/4 W	OHMITE	RC07GF123J
R5	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R6	000154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R7	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R8	000154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R9	000273	RES	CARBON	27 K 5% 1/4 W	OHMITE	RC07GF273J
R14	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R15	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R16	000304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R17	200258					
R18	000304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R19	000393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J
R20	000393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J
R21	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R22	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R23	000304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R24	200258					
R25	000304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R26	000393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J
R27	000393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J
R28	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R29	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R30	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R31	000304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J

PC BOARD ASSEMBLY 10000 DECADE 5 DIGIT 400258

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION		MANUFAC	MANUFAC P/N
R32	020025						
R33	000304	RES	CARBON	300 K	5% 1/4 W	OHMITE	RC07GF304J
R34	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R35	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R36	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R37	000243	RES	CARBON	24 K	5% 1/4 W	OHMITE	RC07GF243J
R38	000243	RES	CARBON	24 K	5% 1/4 W	OHMITE	RC07GF243J
R39	000304	RES	CARBON	300 K	5% 1/4 W	OHMITE	RC07GF304J
R40	020025						
R41	000304	RES	CARBON	300 K	5% 1/4 W	OHMITE	RC07GF304J
R42	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R43	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R44	000243	RES	CARBON	24 K	5% 1/4 W	OHMITE	RC07GF243J
R45	000243	RES	CARBON	24 K	5% 1/4 W	OHMITE	RC07GF243J
R46	000243	RES	CARBON	24 K	5% 1/4 W	OHMITE	RC07GF243J
R47	000304	RES	CARBON	300 K	5% 1/4 W	OHMITE	RC07GF304J
R48	020025						
R49	000304	RES	CARBON	300 K	5% 1/4 W	OHMITE	RC07GF304J
R50	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R51	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R52	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R53	000243	RES	CARBON	24 K	5% 1/4 W	OHMITE	RC07GF243J
R54	000243	RES	CARBON	24 K	5% 1/4 W	OHMITE	RC07GF243J
R55	000304	RES	CARBON	300 K	5% 1/4 W	OHMITE	RC07GF304J
R56	020025						
R57	000304	RES	CARBON	300 K	5% 1/4 W	OHMITE	RC07GF304J
R58	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R59	000393	RES	CARBON	39 K	5% 1/4 W	OHMITE	RC07GF393J
R60	020025						

BOARD ASSEMBLY 1000 DECADE 5 DIGIT 5600-400435

PARTS LIST

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
C1	101098	CAP	CERAM	330 PFD 500 V		10%	AEROVOX	SCD1X5F
CR1 THRU	211083	DIODE	SILICO	018			DANA	211083
CR7	211083	DIODE	SILICO	018			DANA	211083
CR25	211083	DIODE	SILICO	018			DANA	211083
CR36	211083	DIODE	SILICO	018			DANA	211083
CR37	211083	DIODE	SILICO	018			DANA	211083
CR94	211083	DIODE	SILICO	018			DANA	211083
R1	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R2	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R3	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R4	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R5	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R6	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R7	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R8	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R9	000273	RES	CARBON	27 K	5%	1/4 W	OHMITE	RC07GF273J
R10	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R11	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R12	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R13	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R14	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R15	000304	RES	CARBON	300 K	5%	1/4 W	OHMITE	RC07GF304J
R16	020026	RES	WW	99997 OHM	.01%	1 W	JORDAN	S-136
R17	000304	RES	CARBON	300 K	5%	1/4 W	OHMITE	RC07GF304J
R18	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J
R19	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J
R20	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R21	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R22	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R23	000304	RES	CARBON	300 K	5%	1/4 W	OHMITE	RC07GF304J
R24	020026	RES	WW	99997 OHM	.01%	1 W	JORDAN	S-136
R25	000304	RES	CARBON	300 K	5%	1/4 W	OHMITE	RC07GF304J
R26	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J
R27	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J
R28	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J
R29	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R30	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R31	000304	RES	CARBON	300 K	5%	1/4 W	OHMITE	RC07GF304J
R32	020026	RES	WW	99997 OHM	.01%	1 W	JORDAN	S-136

BOARD ASSEMBLY 1000 DECADE 5 DIGIT 5600 - 400435

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
R33	000304	RES	CARBON	300 K	5%	1/4 W	OHMITE	RC07GF3041
R34	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF3931
R35	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF3931
A-R7	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF2431
E-R7	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF2431

PCB ABOARD ASSEMBLY LOWER ORDER DECADE 5600 - 400436

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
C1	101098	CAP	CERAM	330 PFD 500 V 10%	AEROVOX	SCD1X5F
CR1 THRU	211C83	DIODE	SILICO	018	DANA	211083
CR70	211C83	DIODE	SILICO	018	DANA	211083
Q1 THRU	2C1C84	TRANS	GERMAN PNP	2N1304	TI	2N1304
Q11	2C1C84	TRANS	GERMAN PNP	2N1304	TI	2N1304
R1	0C0123	RES	CARBON	12 K 5% 1/4 W	OHMITE	RC07GF123J
R2	0C0243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R3	0C0154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R4	0C0123	RES	CARBON	12 K 5% 1/4 W	OHMITE	RC07GF123J
R5	0C0243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R6	0C0154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R7	0C0243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R8	0C0154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R9	0C0273	RES	CARBON	27 K 5% 1/4 W	OHMITE	RC07GF273J
R10	0C0123	RES	CARBON	12 K 5% 1/4 W	OHMITE	RC07GF123J
R11	0C0243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R12	0C0154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R13	021104	RES	ww	100 K .1% 1/4 W	KELVIN	EP-21
R14	0C0304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R15	0C0304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R16	0C0683	RES	CARBON	68 K 5% 1/4 W	OHMITE	RC07GF683J
R17	0C0393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J
R18	0C0393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J
R19	0C0683	RES	CARBON	68 K 5% 1/4 W	OHMITE	RC07GF683J
R20	021103	RES	ww	50 K .05% 1/4 W	KELVIN	EP-21
R21	0C0304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R22	0C0304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R23	0C0393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J
R24	0C0243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R25	0C0243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R26	0C0393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J
R27	0211C4	RES	ww	100 K .1% 1/4 W	KELVIN	EP-21
R28	0C0304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R29	0C0304	RES	CARBON	300 K 5% 1/4 W	OHMITE	RC07GF304J
R30	0C0683	RES	CARBON	68 K 5% 1/4 W	OHMITE	RC07GF683J
R31	0C0393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J
R32	0C0393	RES	CARBON	39 K 5% 1/4 W	OHMITE	RC07GF393J

PCB ABOARD ASSEMBLY LOWER ORDER DECADE 5600 - 400436

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
R33	000683	RES	CARBON	68 K	5%	1/4 W	OHMITE	RC07GF683J
R34	021106	RES	WW	200 K	.1%	1/4 W	KELVIN	EP-21
R35	000304	RES	CARBON	300 K	5%	1/4 W	OHMITE	RC07GF304J
R36	000304	RES	CARBON	300 K	5%	1/4 W	OHMITE	RC07GF304J
R37	000683	RES	CARBON	68 K	5%	1/4 W	OHMITE	RC07GF683J
R38	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J
R39	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J
R40	000683	RES	CARBON	68 K	5%	1/4 W	OHMITE	RC07GF683J
R41	021105	RES	WW	180 K	.1%	1/4 W	KELVIN	EP-21

PC BOARD ASSEMBLY PROGRAM 5600 - 400296

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
C1	101098	CAP	CERAM	330 PFD 500 V 10%	AEROVOX	SCD1X5F
C2	110002	CAP	TANTA	22 MFD 35 V 10%	KEMET	K22C35K
C3	121473	CAP	MYLAR	.0015 MFD 100 V 10%	CDE	WMF1S47
C4	121147	CAP	MYLAR	.0068 MFD 100 V 10%	CDE	WMF1D68
C5	121090	CAP	MYLAR	.015 MFD 100 V 10%	CDE	WMF1S15
C6	121090	CAP	MYLAR	.015 MFD 100 V 10%	CDE	WMF1S15
C7	111095	CAP	ELECT	1 MFD 25 V 20%	SPRAGUE	TE1200
C8	121394	CAP	MYLAR	.15 MFD 100 V 10%	CDE	WMF1P15
C9	110002	CAP	TANTA	22 MFD 35 V 10%	KEMET	K22C35K
C10	121394	CAP	MYLAR	.15 MFD 100 V 10%	CDE	WMF1P15
CR1 THRU CR9	211083	DIODE	SILICO	018	DANA	211083
CR15	211083	DIODE	SILICO	018	DANA	211083
CR16	211083	DIODE	SILICO	018	DANA	211083
CR17	211083	DIODE	SILICO	018	DANA	211083
CR25	211083	DIODE	SILICO	018	DANA	211083
CR36 THRU CR47	211083	DIODE	SILICO	018	DANA	211083
CR48	220004	DIODE	SILICO	ZENER 1N961B	MOTOROLA	1N961B
CR49	211083	DIODE	SILICO	018	DANA	211083
CR50	220007	DIODE	SILICO	ZENER 1N751	MOTOROLA	1N751
CR51	211083	DIODE	SILICO	018	DANA	211083
CR52	211083	DIODE	SILICO	018	DANA	211083
CR53	211083	DIODE	SILICO	018	DANA	211083
CR54	211083	DIODE	SILICO	018	DANA	211083
Q1	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q2	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q3	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q4	200037	TRANS	SILICO	NPN 2N3646	FAIRCHILD	2N3646
Q5	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q6	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q7	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q8	200022	TRANS	SILICO	PNP 012	DANA	200022
Q9	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q10	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q11	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q12	201084	TRANS	GERMAN	PNP 2N1304	TI	2N1304
Q13	200043	TRANS	SILICO	NPN 2N3565	FAIRCHILD	2N3565
Q14	201083					
R51	000123	RES	CARBON	12 K 5% 1/4 W	OHMITE	RC07GF123J

PC BOARD ASSEMBLY PROGRAM 5600 - 400296

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
R52	000122	RES	CARBON	1.2 K	5%	1/4 W	OHMITE	RC07GF122J
R53	000511	RES	CARBON	510 OHM	5%	1/4 W	OHMITE	RC07GF511J
R54	000203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R55	000113	RES	CARBON	11 K	5%	1/4 W	OHMITE	RC07GF113J
R56	000472	RES	CARBON	4.7 K	5%	1/4 W	OHMITE	RC07GF472J
R57	000163	RES	CARBON	16 K	5%	1/4 W	OHMITE	RC07GF163J
R58	000681	RES	CARBON	680 OHM	5%	1/4 W	OHMITE	RC07GF681J
R59	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R60	000473	RES	CARBON	47 K	5%	1/4 W	OHMITE	RC07GF473J
R61	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R62	000273	RES	CARBON	27 K	5%	1/4 W	OHMITE	RC07GF273J
A-R1	001692	RES	CARBON	4.7 K	5%	1/2 W	OHMITE	RC20GF472J
F-R1	001677	RES	CARBON	2.7 K	5%	1/2 W	OHMITE	RC20GF272J
A-R4	001692	RES	CARBON	4.7 K	5%	1/2 W	OHMITE	RC20GF472J
F-R4	001677	RES	CARBON	2.7 K	5%	1/2 W	OHMITE	RC20GF272J
A-R10	001692	RES	CARBON	4.7 K	5%	1/2 W	OHMITE	RC20GF472J
A-R11	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
H-R12	000753	RES	CARBON	75 K	5%	1/4 W	OHMITE	RC07GF753J
J-R12	000753	RES	CARBON	75 K	5%	1/4 W	OHMITE	RC07GF753J
K-R12	000753	RES	CARBON	75 K	5%	1/4 W	OHMITE	RC07GF753J
L-R12	000753	RES	CARBON	75 K	5%	1/4 W	OHMITE	RC07GF753J
M-R12	000753	RES	CARBON	75 K	5%	1/4 W	OHMITE	RC07GF753J
R1	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R2	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R3	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R4	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R5	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R6	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R7	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R8	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R9	000273	RES	CARBON	27 K	5%	1/4 W	OHMITE	RC07GF273J
R10	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R11	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R12	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R13	000273	RES	CARBON	27 K	5%	1/4 W	OHMITE	RC07GF273J
R14	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R15	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R16	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R17	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R18	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J

PC BOARD ASSEMBLY PROGRAM 5600 - 400296

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
R19	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R20	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R21	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R22	000334	RES	CARBON	330 K	5%	1/4 W	OHMITE	RC07GF334J
R23	001100	RES	CARBON	2.2 K	5%	1/2 W	OHMITE	RC20GF222J
R24	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R25	001100	RES	CARBON	2.2 K	5%	1/2 W	OHMITE	RC20GF222J
R26	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R40	000334	RES	CARBON	330 K	5%	1/4 W	OHMITE	RC07GF334J
R41	000333	RES	CARBON	33 K	5%	1/4 W	OHMITE	RC07GF333J
R42	000103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R43	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R44	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R45	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R46	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R47	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R49	000362	RES	CARBON	3.6 K	5%	1/4 W	OHMITE	RC07GF362J
R50	001261	RES	CARBON	2 K	5%	1/2 W	OHMITE	RC20GF202J

PC BOARD ASSEMBLY AUTO RANGE - 400297

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
C1	1101098	CAP	CERAM	330 PFD 500 V 10%	AEROVOX	SCD1X5F
CR1 THRU	211083	DIODE	SILICO	018	DANA	211083
CR12	211083	DIODE	SILICO	018	DANA	211083
CR15	211083	DIODE	SILICO	018	DANA	211083
CR16	211083	DIODE	SILICO	018	DANA	211083
CR17	211083	DIODE	SILICO	018	DANA	211083
CR37	211083	DIODE	SILICO	018	DANA	211083
CR38	211083	DIODE	SILICO	018	DANA	211083
CR25	211083	DIODE	SILICO	018	DANA	211083
CR26	211083	DIODE	SILICO	018	DANA	211083
Q1	201084	TRANS	GERMAN PNP	2N1304	TI	2N1304
Q2	201084	TRANS	GERMAN PNP	2N1304	TI	2N1304
Q3	201084	TRANS	GERMAN PNP	2N1304	TI	2N1304
R1	001633	RES	CARBON	3 K 5% 1/2 W	OHMITE	RC20GF302J
R2	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R3	000154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R4	001633	RES	CARBON	3 K 5% 1/2 W	OHMITE	RC20GF302J
R5	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R6	000154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R7	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R8	000154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R9	000273	RES	CARBON	27 K 5% 1/4 W	OHMITE	RC07GF273J
R10	000123	RES	CARBON	12 K 5% 1/4 W	OHMITE	RC07GF123J
R11	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R12	000154	RES	CARBON	150 K 5% 1/4 W	OHMITE	RC07GF154J
R40	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R41	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R42	000243	RES	CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
A-R12	000753	RES	CARBON	75 K 5% 1/4 W	OHMITE	RC07GF753J
B-R12	000753	RES	CARBON	75 K 5% 1/4 W	OHMITE	RC07GF753J
C-R12	000753	RES	CARBON	75 K 5% 1/4 W	OHMITE	RC07GF753J
D-R12	000753	RES	CARBON	75 K 5% 1/4 W	OHMITE	RC07GF753J
E-R12	000753	RES	CARBON	75 K 5% 1/4 W	OHMITE	RC07GF753J
L-R10	000562	RES	CARBON	5.6 K 5% 1/4 W	OHMITE	RC07GF562J
C-R1	000822	RES	CARBON	8.2 K 5% 1/4 W	OHMITE	RC07GF822J
C-R4	000822	RES	CARBON	8.2 K 5% 1/4 W	OHMITE	RC07GF822J
D-R1	001677	RES	CARBON	2.7 K 5% 1/2 W	OHMITE	RC20GF272J
D-R4	001677	RES	CARBON	2.7 K 5% 1/2 W	OHMITE	RC20GF272J

PCB ASSEMBLY DIGIT READOUT BASIC 400463

P A R T S L I S T

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
CR3 THRU	211083	DIODE	SILICO	018	DANA	211083
CR6	211083	DIODE	SILICO	018	DANA	211083
Q5	200035	TRANS	SILICO	NPN 014	DANA	200035
R7	000243	RES	CARBCN	24 K 5% 1/4 W	OHMITE	RC07GF243J
R-R7	000153	RES	CARBCN	15 K 5% 1/4 W	OHMITE	RC07GF153J
B-R7	000153	RES	CARBON	15 K 5% 1/4 W	OHMITE	RC07GF153J
B-R7	000153	RES	CARBON	15 K 5% 1/4 W	OHMITE	RC07GF153J
N-R7	000153	RES	CARBCN	15 K 5% 1/4 W	OHMITE	RC07GF153J
R40	001698	RES	CARBCN	20 K 5% 1 W	OHMITE	RC32GF203J
R41	000205	RES	CARBON	2 M 5% 1/4 W	OHMITE	RC07GF205J
R42	000205	RES	CARBCN	2 M 5% 1/4 W	OHMITE	RC07GF205J
R43	001698	RES	CARBCN	20 K 5% 1 W	OHMITE	RC32GF203J

PCB ASSEMBLY READOUT 400467

P A R T S L I S T

REF DES	DANA P/N	PART TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
CR3 THRU	211083	DIODE SILICO	018	DANA	211083
CR6	211083	DIODE SILICO	018	DANA	211083
Q5	200035	TRANS SILICO	NPN 014	DANA	200035
R7	000243	RES CARBON	24 K 5% 1/4 W	OHMITE	RC07GF243J
R42	001698	RES CARBON	20 K 5% 1 W	OHMITE	RC32GF203J
R43	C00205	RES CARBON	2 M 5% 1/4 W	OHMITE	RC07GF205J
XR7	C00153	RES CARBON	15 K 5% 1/4 W	OHMITE	RC07GF153J
YY7	000153	RES CARBON	15 K 5% 1/4 W	OHMITE	RC07GF153J

INTRODUCTION

The Dana Model 20 and 25 AC Converters are signal conditioning plug-in circuit cards for use with Dana Series 5600, 5603 and 5640 voltmeters, (DVM's). When installed in a DVM which is properly wired, it allows AC Voltages to be measured with the normal voltmeter leads. They are contained within and derive power supply voltages from the digital voltmeter. The guarded input characteristics of the Dana DVM are retained for AC measurements. Full resolution of the DVM is available for AC measurements including the 1 volt full scale range.

SPECIFICATIONS
MODEL 20 AND 25

Function	Converts AC voltage into proportional DC voltages, which are measured by the DVM; all specifications refer to output of DVM as a function of AC voltage input
Frequency Range	
Model 20	10 cps to 20,000 cps
Model 25	10 cps to 100,000 cps
Maximum voltage	500 volts RMS, 50 cps to 10 kc, decreasing to 150 volts at 50 kc and above
Full scale ranges	.99999, 9.9999, 99.999, 999.99
Accuracy	
Model 20 (20 kc)	±0.1% of reading or ±0.02% of f.s., 50 cps to 10 kc; ±0.25% of reading or ±0.03% of f.s., 10 kc to 20 kc
Model 25 (100 kc)	±0.1% of reading or ±0.02% of f.s., 50 cps to 10 kc; ±0.25% of reading or ±0.05% of f.s., 10kc to 50 kc; ±0.5% of reading or ±0.1% of f.s., 50 kc to 100 kc
Response Time	
Step response	0.4 second to within 0.1% of final value
Response time with range change	1.6 seconds
Input characteristics	
Input resistance	1 megohm, all ranges
Shunt capacitance (exclusive of external cable)	less than 47 pf, all ranges
Calibration	RMS for sine wave input; 1.11 times full wave average magnitude for other wave forms
Dana Certification	Sine wave
Range Control	Automatic with manual override selected by knob on DVM front panel

AC Converter

Typical Accuracy	10 - 50 cps: 1% of reading or 0.2% of full scale of range, whichever is greater
Decimal Point Indication	Automatic
Isolation	AC input is isolated and guarded from ground, the AC power line, electrical output
Size and Mounting	AC converter is enclosed entirely within Dana Series 5600 DVM (5 1/4" high EIA rack); there are no additional cables, connectors, or controls
Card Location	Address 21
Color Code	Yellow/Grey

DESCRIPTION

The Model 20/25 AC Converter is an all solid state circuit card that accepts an AC signal and converts it to a DC voltage which is measured by the DVM. When used in a Dana Series 5600, highly precise AC measuring capability is provided with automatic range selection.

The converter is essentially an AC amplifier with precise gain followed by a full wave rectifier and a low pass filter.

The converter senses the average value of the waveform and scales the output to indicate the RMS value of a sine wave.

Because the converter must present a stable and precise DC output, the output is well filtered; the time constant of the converter is a result of this filtering.

OPERATION

When the Model 20, (25), is installed in a Dana DVM, full AC measuring capability is available using the normal input leads. Basically, operation of the DVM for AC measurements is the same as for DC measurements, since the normal guarded input circuit is utilized, and all automatic features are available.

Referring to Figure 5.1 of the Basic DVM manual, the Function switch is placed in "AC Volts", The Range switch may be either on one of the manually selected ranges or in "Auto".

Some care should be taken to select the correct Mode position. For most measurements, the "Tracking" mode should be used. This allows the DVM to track any significant change in voltage with new readings as often as 5 times per second.

When the "Tracking" mode is used and a range change occurs, an internal delay allows the filter to settle to full accuracy before a new reading is taken.

Much greater stability at all frequencies, and especially lower frequencies, can be obtained by using the internal DVM Filter. The only disadvantage in this operation is a slightly longer settling time and range change.

STANDARDS LABORATORY CALIBRATION PROCEDURE FOR DANA
AC CONVERTER MODELS 20 AND 25

Equipment Required:

AC Signal source, 50 cps to 100 kc, 0-500.00 volts RMS with less than 0.03% distortion.

Dana DVM extender card assembly and converter input extender cable (supplied with an AC Calibration Kit, Part No. 400919).

GENERAL

There are nine (9) adjustments on the Model 20 and 25 Converters. One unmarked potentiometer (top of unit nearest the rear) is to adjust for zero output with the input shorted. The remaining eight (8) adjustments are to calibrate the units four ranges. Each range has potentiometer to calibrate at low frequencies and a trim capacitor for high frequency calibration. The eight calibration adjustments are clearly marked immediately adjacent to each control. It is important that calibration be performed in the following sequence.

1.0 With the DVM power OFF, insert the converter with extender card, support bracket, and extender cable into the DVM.

1.1 Turn the power on and allow the voltmeter to warm up 30 minutes.

2.0 Zero Adjustment

2.1 Place the Function switch to AC volts, "Range" to 100, and "Mode" to PERIODIC.

2.2 Set DVM to its 100 volt range and short the input. Adjust the zero potentiometer clockwise until an offset is observed. Reverse the adjustment to the point of zero display.

NOTE: After each range is calibrated, it should be checked for proper response. Suggested points are:

Model 20 - $\pm$0.1% at 50 cps, 400 cps, 1 kc, 5 kc, and 10 kc or $\pm$0.02% of full scale; $\pm$0.25 at 20k or $\pm$0.03% of full scale.

Model 25 - $\pm$0.1% at 50 cps, 400 cps, 1 kc, 5 kc, and 10 kc or $\pm$0.02% of full scale; $\pm$0.25% at 25 kc and 50 kc or $\pm$0.05% of full scale; $\pm$0.5% at 100 kc or $\pm$0.1% of full scale.

3.0 1000 volt range - Set the DVM to its 1000 v range, mode switch to periodic and function selector to AC volts. Set the AC source to 500 volts at 400 cps and adjust the 1000 volt potentiometer for minimum error. Set the AC source to 125 volts at *50 kc and adjust the 1000 v trim capacitor for minimum error. Repeat these two steps as required, being careful to check the *50 kc calibration last.

4.0 100 volt range - Set the DVM to the 100 v range, periodic, and AC volts. Set the AC source to 99 volts at 400 cps and adjust the 100 volt potentiometer for minimum error. Set the AC source to 99 volts at *50 kc and adjust the 100 volt trim capacitor for minimum error. Repeat these two steps as required, checking calibration at *50 kc last.

5.0 1 volt range - Set the DVM to the 1 v range, periodic, and AC volts. Set the AC source to .99 volts at 400 cps and adjust the 1 volt potentiometer for minimum error. Set the AC source to .99 volts at *50 kc and adjust the 1 volt trim capacitor for minimum error. Repeat these two steps as required, checking calibration at *50 kc last.

6.0 10 volt range - Set the DVM to the 10 v range, periodic and AC volts. Set the AC source to 9.9 volts at 400 cps and adjust the 10 volt potentiometer for minimum error. Set the AC source to 9.9 volts at *50 kc and adjust the 10 volt trim capacitor for minimum error. Repeat these two steps as required, checking calibration at *50 kc last.

7.0 Final Check - Remove the converter from the extender card and install it in its operational position. Check the accuracy of each range at several frequencies over the range of 50 cps to *50 kc. If any single range requires adjustment, recheck lower ranges sequentially beginning with the highest applicable range. As each range is readjusted, check calibration at *50 kc last.

8.0 Sequence of Adjustments - After the details of calibration are learned, the summary shown below will serve to expedite calibration.

Range	Test Voltage	Test Frequency	Adjustment
100 volt	Shorted input		Zero Potentiometer for zero display
1000 volt	500 volts	400 cps	1000 v potentiometer
1000 volt	125 volts	*50 kc	1000 trim capacitor
100 volt	99 volts	400 cps	100 v potentiometer
100 volt	99 volts	*50 kc	100 v trim capacitor
1 volt	.99 volts	400 cps	1 v potentiometer
1 volt	.99 volts	*50 kc	1 v trim capacitor
10 volt	9.9 volts	400 cps	10 v potentiometer
10 volt	9.9 volts	*50 kc	10 v trim capacitor

* For Model 25 AC Converter only - Use 10 kc source for Model 20.

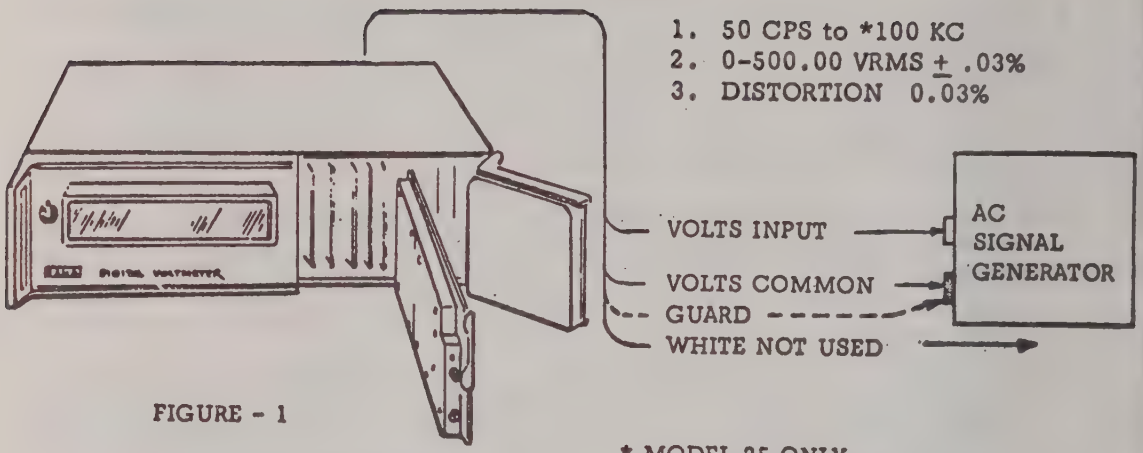
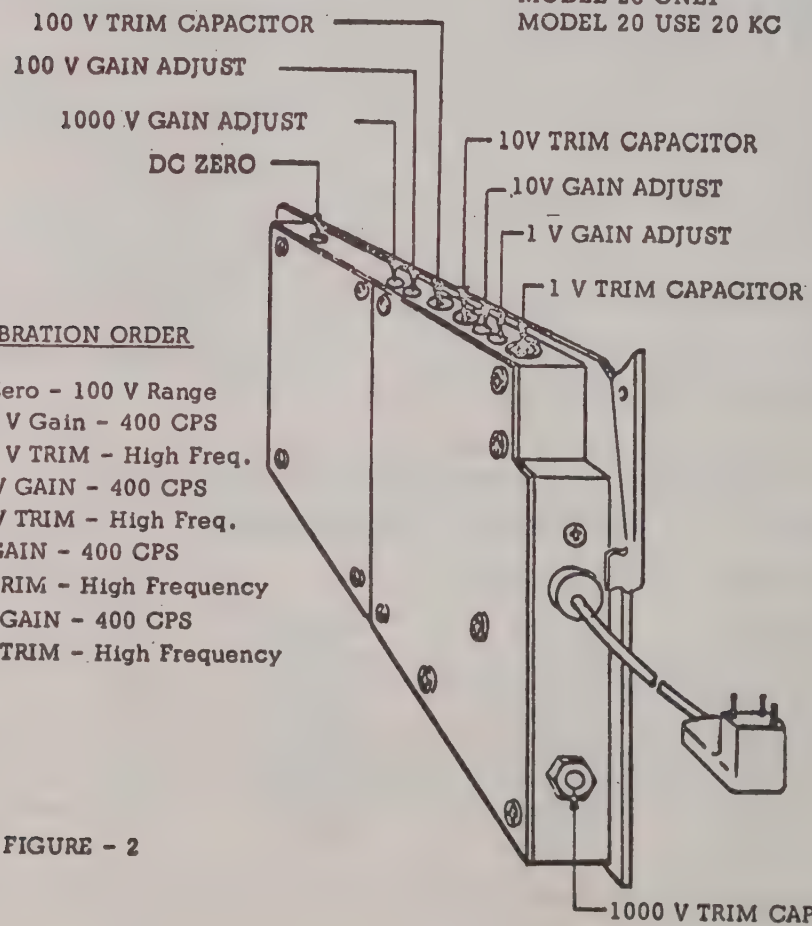


FIGURE - 1

* MODEL 25 ONLY -
MODEL 20 USE 20 KC



CALIBRATION ORDER

1 - DC Zero - 100 V Range
2 - 1000 V Gain - 400 CPS
3 - 1000 V TRIM - High Freq.
4 - 100 V GAIN - 400 CPS
5 - 100 V TRIM - High Freq.
6 - .1 V GAIN - 400 CPS
7 - 1 V TRIM - High Frequency
8 - 10 V GAIN - 400 CPS
9 - 10 V TRIM - High Frequency

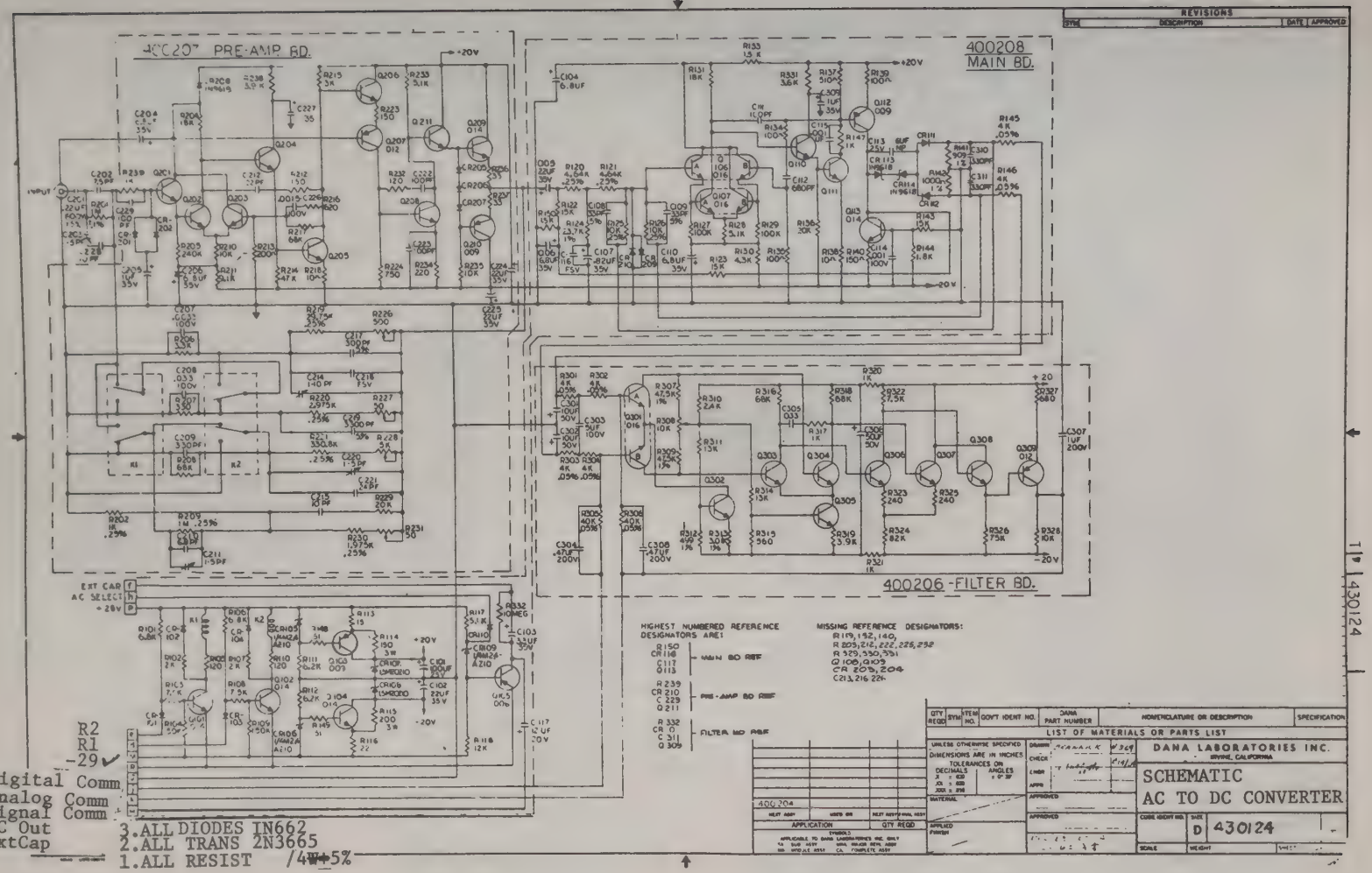
FIGURE - 2

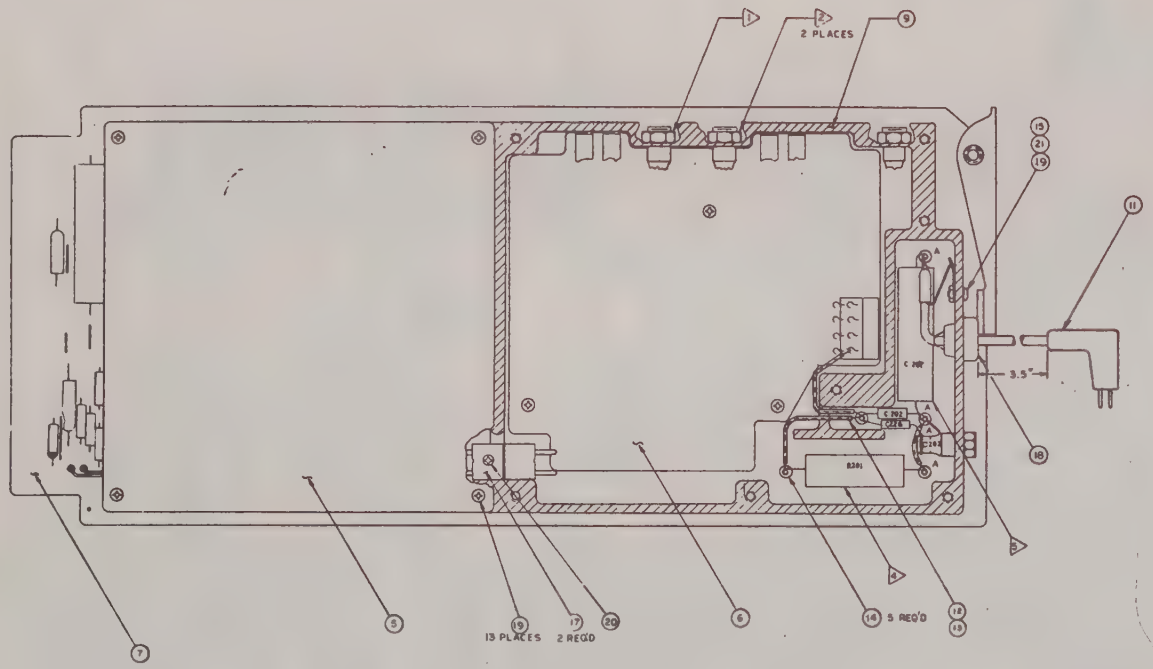
AC CONVERTER SPARE PARTS LIST
MODEL 20 & 25
Less 5% Carbon Resistors

PART NO.	DESCRIPTION	QTY	REC'D SPARES	APPROX. PRICE
RESISTORS				
010027	499 ohms, RN60B, Metal Film	1	1	.60
010069	22.6K, 1%, RN60B, Metal Film	1	1	.60
010140	4.64K, ±.25%, RN60C, Metal Film	2	1	3.95
010141	10K, RN60C, ±.25%, Metal Film	2	1	3.95
010142	909 ohm, 1%, RN60B, Metal Film	1	1	2.55
010148	1 Meg., .1%, RN75C, Metal Film	1	1	4.70
010150	29.75K, .25%, RN60C, Metal Film	1	1	3.00
010151	Resistor - 2.975K, .25%, RN60C, Metal Film	1	1	3.00
010152	330.8K, .25%, RN60C, Metal Film	1	1	3.00
010153	1.955K, .25%, RN60C, Metal Film	1	1	3.00
010154	1 Meg, .25%, RN65C, Metal Film	1	1	3.00
010155	1K, .25%, RN60C, Metal Film	1	1	3.00
011332	1K, 1%, RN60B, Metal Film	1	1	1.15
011408	3.01K, Deposted Carbon	1	1	.70
020037	40K, .05%, Wirewound	2	1	4.50
020038	4K, .05%, Wirewound	6	1	3.50
021244	47.5K, .1%, Wirewound	2	1	3.50
POTENTIOMETERS				
040005	10K, Bourns #3067P-1-1-3	1	1	4.50
040012	50 ohm, Techno Model 40	1	1	10.50
040027	5K, Techno Model 40	1	1	10.50
CAPACITORS				
100005	22pf, Ceramic Disc	1	1	2.00
101098	330pf, 10%, Ceramic Disc	3	3	.15
101099	680pf, Ceramic Disc	1	1	.15
101145	100pf, Ceramic Disc	2	1	.15
101182	47pf, Ceramic Disc	1	1	.20
110001	6.8uf, 35V, Tantalum	2	1	2.40
110002	22uf, 35V, Tantalum	4	1	3.80
110005	10uf, 50V, Tantalum, Semcor, TSW1K-50-106	1	1	5.00
110007	6uf, 25V, Tantalum	1	1	8.00
110017	1uf, 35V, Tantalum	5	1	1.60
110019	0.82uf, 35V, 5%, Tantalum	1	1	1.90
110022	3.3uf, 35V, 10%, Tantalum	1	1	1.65
111097	50uf, 50V, Electrolytic	1	1	1.25
111148	100uf, 25V, Electrolytic	1	1	.90
120001	.0033uf, 100V, Mylar	1	1	.30
120005	.001uf, 100V, Mylar	1	1	.45
120007	.22uf, 600V, Mylar	1	1	3.75

AC CONVERTER PARTS LIST

PART NO.	DESCRIPTION	QTY	REC'D SPARES	APPROX. PRICE Ea.
CAPACITORS				
120010	.47uf, 200v, Electrocube (Matched Pair)	1	1	16.50
120012	1.0uf, 200V, Mylar	1	1	3.50
120016	5uf, 100V, 10%, Mylar	1	1	9.00
120035	33pf, 5%, Polystyrene	2	1	.45
120036	3300pf, Polystyrene	1	1	.65
120037	300pf, Polystyrene	1	1	.45
120038	27pf, Polystyrene	1	1	.45
120039	24 pf, Polystyrene	1	1	.45
121091	.033uf, 100V, Mylar	2	1	.25
121473	.0015uf, 100V, Mylar	1	1	.25
130029	1-5pf, Trimmer, Corning #682116	3	1	10.90
130030	1-10pf, Trimmer, Corning #68117	1	1	10.50
130031	8.2pf, 10%, Glass	2	1	6.75
TRANSISTORS				
200005	TI-415	19	2	1.75
200011	Type 009	3	1	10.00
200017	Type 001	2	1	3.50
200022	Type 012	3	1	4.50
201176	SS71032B	1	1	81.00
211083	Diode - IN662	15	4	.50
220013	Diode - Zener, IN3796	2	1	
221177	Diode - Zener, 1/4M2.4AZ10	3	1	2.25
221254	Diode - Zener, IN961A	2	1	7.50
310011	Relay - Babcock #BR-16	2	1	42.00
600082	Connector - 4-Pin, Winchester #JF-2P-2P	1	1	1.98
600083	Connector - 4-Socket, Winchester #JF-2S-2S	1	1	2.40
459348	Plate-Cover (Model 20)	1	0	
450551	Plate - Cover (Model 25)	1	0	


400220 PRE-AMP BD.
400208 MAIN BD.
400206 - FILTER BD.
REVISIONS
DESCRIPTION
DATE
APPROVED
HIGHEST NUMBERED REFERENCE DESIGNATORS ARE:
R150
CR116
C117
Q113
MAIN BD REF
R239
CR210
C229
Q211
PRE-AMP BD REF
R332
CR 0
C311
Q309
FILTER BD REF
MISSING REFERENCE DESIGNATORS:
R119,182,140,
R 205,216,222,226,230
R 329,330,331
Q 108,Q109
CR 209,204
C213,216 224
LIST OF MATERIALS OR PARTS LIST
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC
AC TO DC CONVERTER
400204
D
430124
Digital Comm
Analog Comm
Signal Comm
DC Out
ExtCap
3.ALL DIODES IN662
2.ALL TRANS 2N3665
1.ALL RESIST /4W ±5%
R2
R1
-29
7-11
430124



CROSS REFERENCE CHART

Item No	Parts No.
5	400206
6	400207
7	400208
9	450307
11	450390
12	500004
13	501326
14	600030
15	600032
17	600083
18	610143
19	615042
20	615269
21	617004

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED

LIST OF MATERIALS OR PARTS LIST

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
1		1		400394		
1		1		400383		

NEXT ASSY | USED ON | NEXT ASSY/FINAL ASSY

APPLICATION | QTY REQD

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA SUB ASSY MFA UNIT REPL ASSY
MA MODULE ASSY CA COMPLETE ASSY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS X ± .020 XX ± .010 XXX ± .005
ANGLES ± 0° 30'

MATERIAL SEE B/M

APPLIED FINISH

DRAWN 10 Feb
CHECK
ENGR 7/11/60
APPD
APPROVED
APPROVED

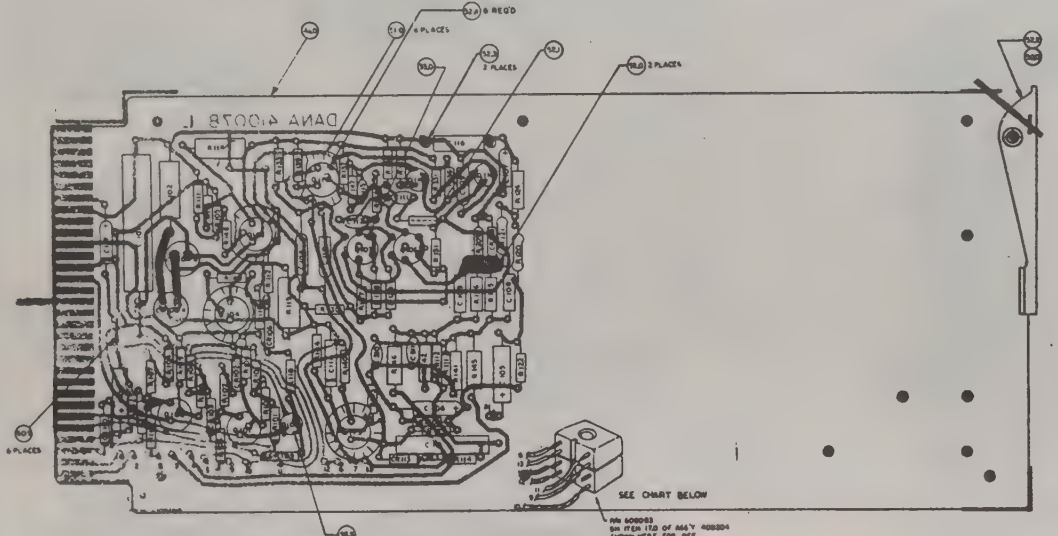
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

AC/DC CONVERTER ASS'Y

CODE IDENT NO. | SIZE D | 400204 | Y

SCALE 2/1 | WEIGHT | SHEET

400204



NO	COLOR
1	VIO
2	BLU
3	GRN
4	YEL
5	ORG
6	RED
7	BRN
8	GRN
9	YEL
10	WHT - ORG
11	RED
12	WHT - RED
13	ORG
14	WHT - BRN

7 WIRE SPECTRASTRIP BETWEEN 400206 & 400208

CROSS REFERENCE CHART

Item No.	Parts No.
46.0	410078
50.0	451036
50.5	500004
51.0	600016
52.0	600137
52.1	600245
52.2	610010
52.3	610234
52.4	920006
52.5	920007
53.0	920032

REF DES	ITEM	VALUE
C117	34.9	12 UF/20V
C116	33.5	7.5V
C101	33.5	100 UF 25V
R***	3.5	10 MEG
CR3-1	14.5	36K
R140	27	4K .05% WW
R139	27	4K .05% WW
R144	9	18K
R143	7	15K
R142	26	1K 1%
R141	25	909Ω 1%
R140	6	150Ω
R139	2	100Ω
R138	1	10Ω
R137	16	510Ω
R136	11	20K
R135	2	100Ω
R134	2	100Ω
R133	6.5	15K
R131	9.5	18K
R130	15	4.3K
R129	3	100K
R128	17	2.1K
R127	3	100K
R126	25.5	0.05% WW
R125	25.5	0.05% WW
R124	22	3.24K 1%
R123	7	15K
R122	7	15K
R121	25.5	3.64K .25%
R120	25.5	3.64K .25%
R118	5	12K
R117	17.0	5.1K
R116	12	22Ω
R115	27.7	200Ω 3W
R114	27.6	150Ω 3W
R113	5.5	13Ω
R112	18	6.2K
R111	18	6.2K
R110	4	120Ω
R109	8	130K
R107	10	2K
R106	19	6.8K
R105	4	120Ω
R104	8	150Ω
R103	20	7.5K
R102	10	2K
R101	19	6.8K

REF DES	ITEM	VALUE
R147	2.5	1K
R108	20	75K
R148	17.5	51K
R149	17.5	51K
R150	6.5	15K
Q113	41.3	Q14
Q112	39	Q09
Q111	41.9	2N3645
Q110	41.9	2N3645
Q107	41.8	Q16
Q106	41.8	Q16
Q105	42.5	Q06
Q104	41.3	Q14
Q103	39	Q09
Q102	41.3	Q14
Q101	41.3	Q14
CR114	43.5	1N963B
CR113	43.5	1N963B
CR209	43	IN645
CR208	43	IN645
CR112	43	IN645
CR111	43	IN645
CR110	43	IN645
CR109	43	1N4742A10
CR108	43.5	1N5210
CR107	43.5	1N5210
CR106	43	1N4742A10
CR105	43	1N4742A10
CR104	43	IN645
CR103	1	1
CR102	1	1
CR101	43	IN645
C311	28	330 PF
C310	28	330 PF
C309	33	1 UF / 35V
C115	29.5	.001 UF
C114	36	.001 UF/100V
C113	32	6 UF/25V
C112	29	680 PF
C111	30	.001 PF
C110	30.5	6 8 UF/35V
C109	37	33 PF
C108	37	33 PF
C107	33.2	82 UF/35V
C106	30.5	6.8 UF/35V
C105	31	22 UF/35 V
C104	30.5	6 8 UF/35V
C103	34.3	3 3 UF/ 35V
C102	31	22 UF/35V

CITY HEIGHT	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION
					LIST OF MATERIALS OR PARTS LIST	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS .X ± .020, .XX ± .010, .XXX ± .005; ANGLES ± 0° 30'

DRAWN Joe Mallard 11-24-64
CHECK [illegible] 11-6-64
CHECK [illegible] 11-24-64
APPD [illegible] 11-24-64
MATERIAL SEE B/M
APPROVED
APPLIED FINISH

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

PC BD ASS'Y-AC/DC CONVERTER MAIN

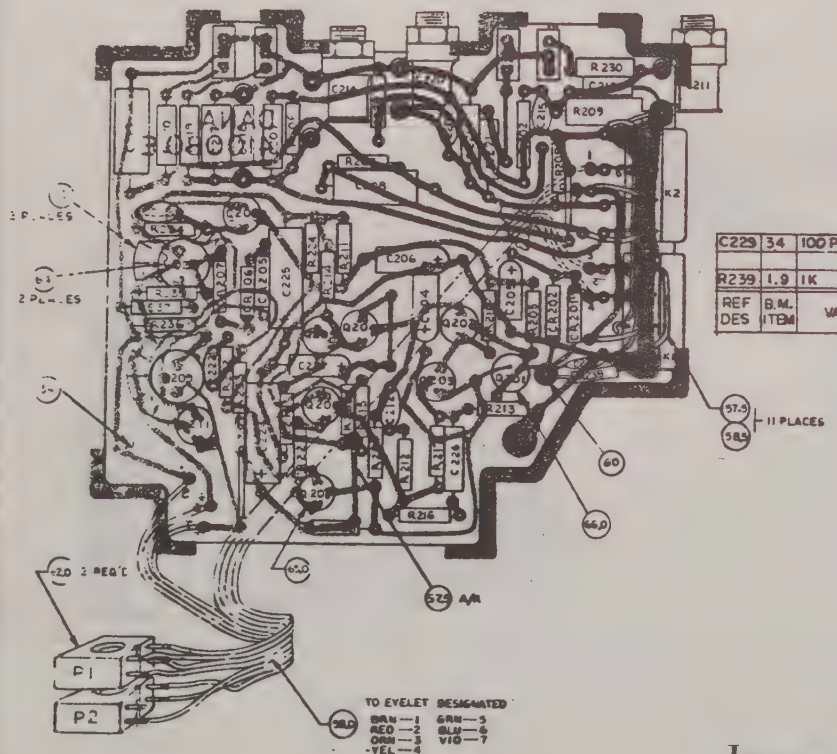
CODE IDENT NO. D | DWG NO. 400208 | REV T
SCALE | WEIGHT | SHEET 1 OF 1

APPLICATION: CITY REQD

7-13

T 400208

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED



REF DES	B.M. ITEM	VALUE
C229	34	100 PF
R239	1.9	1K

REF DES	B.M. ITEM	VALUE
K1&2	33.5	RELAY
R238	14.0	3.9 K
R237	11	33Ω
R236	11	33Ω
R235	2	10 K
R234	8	220Ω
R233	16	5.1 K
R232	3	120Ω
R231	31	50Ω POT.
2 R230	28.7	1.975K .25%
R229	7	20K
R228	30	5K POT
R227	31	50Ω POT.
R226	29	500Ω POT.
R224	19	750Ω
R223	4	150Ω
2 R221	28.7	330.8K .25%
2 R220	28.7	2.975K .25%
2 R219	28.7	9.75K .25%
R218	1	10Ω
R217	18	68 K
R216	17	620Ω
R215	10	3K
R214	15	47K
R213	6	200Ω
R212	4	150Ω
R211	21	9.1K
R210	2	10K
2 R208	28.7	1M .25%
R208	18	68K
R207	12	330Ω
R206	13	3.3K
R205	9	240 K
R204	5	18K
2 R202	28.7	1K .25%

REF DES	B.M. ITEM	VALUE
C227	37	1UF 35V
Q211	49	2N3565
Q210	50	009
Q209	51.3	014
Q208	49	2N3565
Q207	51	012
Q206	49	2N3565
Q205		
Q204		
Q203		
Q202		
Q201	49	2N3565
CR208	52.5	IN9618
CR207	52	IN662
CR206	52	IN662
CR205	52	IN662
CR202	52	IN662
CR201	52	IN662
C226	45	.0015 UF 100V
C225	36	22 UF
C224	36	22 UF
C223	34	100 PF
C222	34	100 PF
C221	47.5	24 PF
C220	46	1-5 PF
C219	47.7	3300 PF
C218		FSV
C217	47.6	300 PF
C215	32.5	10 PF
C214	47	1-10 PF
C212	32	22 PF
C211	46	1-5 PF
C210	47.3	6.8 PF
C209	33	330 PF
C208	44	.033 UF
C207	38	.033 UF
C206	35	6.8 UF
C205	3*	1 UF
C204	35	6.8 UF

QTY REQD	SYM	ITEM NO.	GOVT IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION

LIST OF MATERIALS OR PARTS LIST

400204			
NEXT ASSY	USED ON	NEXT ASSY	ADDITIONAL ASSY
APPLICATION		QTY REQD	

APPLICABLE TO DANA LABORATORIES INC. ONLY
BA — BASIC ASSY; BRA — BASIC REPL. ASSY
MA — MODULE ASSY; CA — COMPLETE ASSY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS X ± .010, XX ± .005, XXX ± .010; ANGLES ± 0° 30'

MATERIAL: SEE B/M

FINISH

DRAWN: Joe Wallace 10-28-65
CHECK: [illegible] 2-1-63
ENGR: [illegible] 9-23-63
APPR: [illegible]
APPROVED
APPROVED
DATE 9-13-65

DANA LABORATORIES INC.
SANTA ANA, CALIF.

P.C. BD ASSY - PRE/AMP, AC/DC CONVERTER

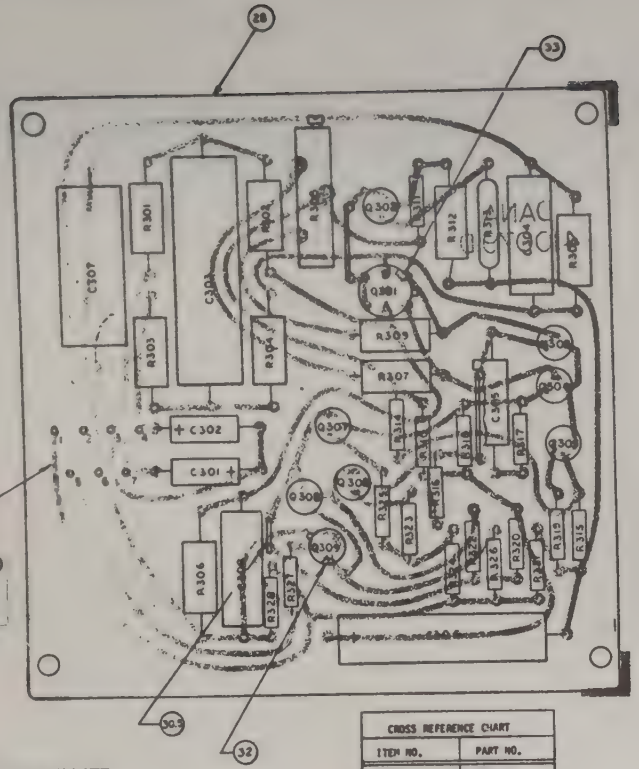
CODE IDENT NO. —
SIZE C
400207
L
SCALE 2/1
WEIGHT
SHEET 1 OF 1

⚠2 RESISTOR SET - PYLOFILM "MATCHED BATCH" P/N 010261

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS 1/4W+5%

LTCT and PATENT 1965

SYM	DESCRIPTION	DATE / APPROVED



R324	12	82 K
R323	4	240Ω
R322	10	7.5K
R321	1	1K
R320	1	1K
R319	6	3.9K
R318	9	68K
R317	1	1K
R316	9	68K
R315	7	560Ω
R314	3	13K
R313	13,5	3.01K 1%
R312	13	499A 1% METAL FILM
R311	3	13K
R310	5	2.4K
R309	17	47.5K WW, .1%
R308	18	10K, POT
R307	17	47.5K WW, .1%
R306	15	40K WW, .05%
R305	15	40K WW, .05%
R304	16	4K WW, .05%
R303	16	4K WW, .05%
R302	16	4K WW, .05%
R301	16	4K WW, .05%
REF DES	B.M. ITEM	VALUE

Q309	26	012
Q308	26.8	2N3565
THRU		
Q302	26.8	2N3565
Q301	26.6	016

⚠ C308	21	.47 UF/200 V
C307	22	1 UF/200 V
C306	20	50 UF/50 V
C305	24	.033 UF/100V
⚠ C304	21	.47 UF/200 V
C303	23	5 UF/100 V
C302	19	10 UF/50 V
C301	19	10 UF/50 V

R328	2	10K
R327	8	680Ω
R326	11	75K
R325	4	240Ω
REF DES	B.M. ITEM	VALUE

WIRE NO.	COLOR
1	NOT - BRN - RED
2	VIO
3	BRN
4	GRN
5	ORG
6	BLU
7	WHT - BRN

CROSS REFERENCE CHART	
ITEM NO.	PART NO.
28	410079
30.5	260004
31	260019
32	920007
33	920082

QTY REQD	SYM	ITEM NO.	GOV'T IDENT NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	SPECIFICATION

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: X ± .030, .XX ± .020, .XXX ± .010
ANGLES ± 0° 30'

DRAWN	J. HALLAM	NOV 3, 64
CHECK	A. Harris	6-3-65
ENGR		3-23
APPR		6-5

MATERIAL
APPROVED
APPLIED FINISH
APPROVED
Rel 7-13-65
DR # 149

DANA LABORATORIES INC.
SANTA ANA, CALIF.

P.C. BD ASSY -
AC/DC CONVERTER, FILTER

CODE IDENT NO.	SIZE	400206	H
	C		

SCALE 2/1 | WEIGHT | SHEET 1 OF 2

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

SYMBOLS
APPLICABLE TO DANA LABORATORIES INC. ONLY
SA — SUB-ASSY MRA — MAJOR REPL ASSY
MA — MODULE ASSY CA — COMPLETE ASSY

H 400206

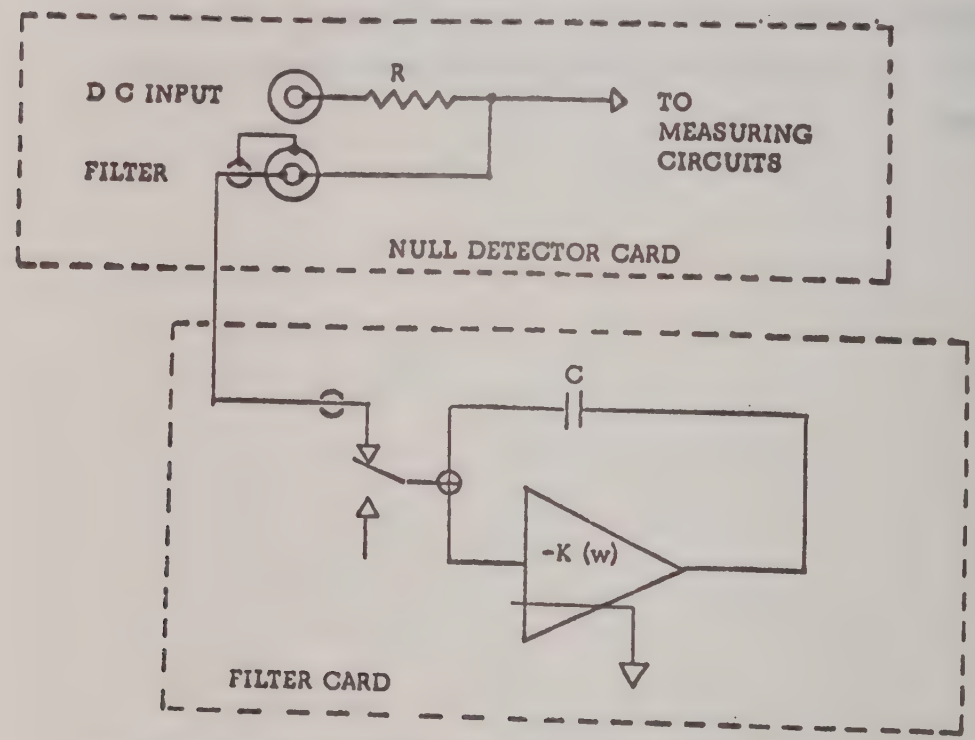
MODEL 58-S-638

INTRODUCTION

The Model 58-S-638 input filter is designed for use with Dana Series 5600 Digital Voltmeters. When installed in a DVM the filter allows precise DC voltage measurements to be made in the presence of line frequency hum or other superimposed AC signals. Except for balance time, the operation of the digital voltmeter is not disturbed by the filter.

DESCRIPTION

The Model 58-S-638 Input Filter is a critically damped three-pole capacitance multiplier. This circuit, combined with the input divider resistance (see Figure), forms an active RC filter network. Amplifiergain, -k(w), increases the effective value of C proportionally to the cube of the input frequency.



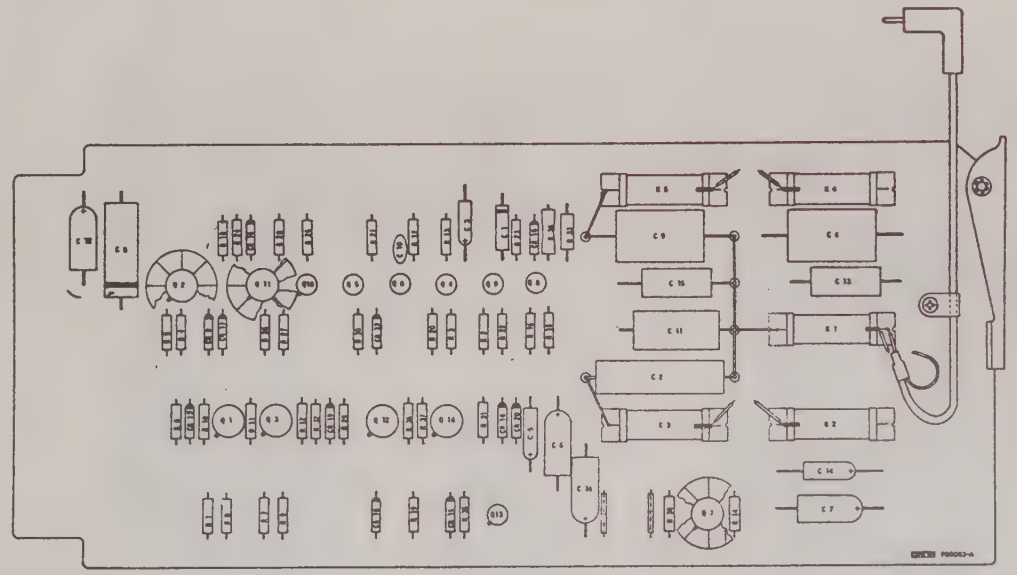
Amplifier gain is changed by switching components in the amplifier feedback network. This is done by externally operated relays which select either 37dB or 80dB minimum AC rejection.

Referring to the schematic, Q3 is a logical inverter. Q7, Q9 drive the Filter in/out relay, and Q13 serves as a switch connecting C7 to the "Timeout" circuit in the DVM, increasing ranging and polarity delays to approximately 1.5 times the filter settling time. The balance of the Transistors Q2, Q4, Q5, Q6, Q10, Q11, Q8, and Q9, comprise the amplifier. In the Model 58 Filter the switch changes C2, C4, C9, and C7 to the appropriate value for the selected 60 cycle rejection.

When operating with the filter, time must be allowed after each input change for the filter to settle to the new value. If automatic range or polarity changes are required, additional time is automatically provided by increasing the period of the internal timeout circuit. If no range or polarity changes are involved, the operator must wait for the reading to stabilize.

SPECIFICATIONS

AC Rejection		
60 cps and above	37dB min	80 dB min
300 cps and above	80dB min	100dB min
Settling time to within 0.01% with up to 100k source resistance	200msec	950msec
Maximum source resistance	1 megohm	1 megohm
Cutoff rate	18dB/oct	18dB/oct
AC input impedance		
10v range	900 kilohm min	900 kilohms min
100 and 1000v ranges	9 megohm min	9 megohm min



REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

REF DES	SYM PTRN	DESCRIPTION
R 5		250Ω
R 1		250Ω
Q10		2N697
Q12		2N962
Q13		2N962
Q17		2N2614
Q16		2N962
Q15		2N4398
Q14		2N962
CR13		
4 DIM		
CR 18		1N962
C 16		.22 uf 35V
C 15		.012 uf 200V
C 14		2.2 uf 35V
C 13		.012 uf 200V ± 5%
C 12		22 uf 35V
C 11		.0214 uf 200V
C 10		220 pf
C 9		.033 uf 100 V
C 8		.22 uf 100V
C 7		22 uf 35V
C 6		100 uf 10V
C 5		6.8 uf 35V
C 4		.056 uf 100 V
C 3		6.8 uf 35V
C 2		.22 uf 100V
C 1		.0242 uf

REF DES	SYM PTRN	DESCRIPTION
R 10		47 OHM
R 17		6.7 Ω
R 14		332 Ω
R 15		22.1KΩ
R 24		6.3 Ω
R 13		6.3 Ω
R 12		24 Ω
R 11		24 Ω
R 16		12 Ω
R 9		6.7 Ω
R 8		24 Ω
R 7		24 Ω
R 6		191 Ω
R 5		165 OHM
R 4		27 Ω
R 3		536 OHM
R 2		20 Ω
R 1		24 Ω
Q 14		2N1304
Q 13		2N1304
Q 12		2N1304
Q 11		2N1304
Q 10		2N1304
Q 9		2N2845
Q 8		2N2845
Q 7		2N2845
Q 6		2N2845
Q 5		2N2845
Q 4		2N2845
Q 3		2N2845
Q 2		2N2845
Q 1		2N1304

REF DES	SYM PTRN	DESCRIPTION
R 28		47 OHM
R 27		24 Ω
R 26		24 Ω
R 25		28.4KΩ
R 24		887 Ω 0943
R 22		665 Ω 0940
R 21		12 Ω
R 21		12 Ω
R 20		24 Ω
R 29		100 Ω
R 28		75 OHM
R 27		3 Ω
R 26		1.2 Ω
R 25		1.5 Ω
R 24		47 OHM
R 23		470 OHM
R 22		470 Ω
R 21		47 OHM
R 20		100 Ω
R 19		20 Ω

QTY REQD	SYM	ITEM NO.	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS | ANGLES
.X ± .030 | ± 0° 30'
.XX ± .020
.XXX ± .010
FORMED ANGLES ± 1.0°
CONCENTRICITY BETWEEN DIA ON THE SAME AXIS SHALL NOT EXCEED .010 TIR.
INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL-D-1000 AND MIL-D-70327

CONTRACT NO.

	NAME	DATE
DR	A CHAUSSEE	5-23-64
CHK		
APPD		

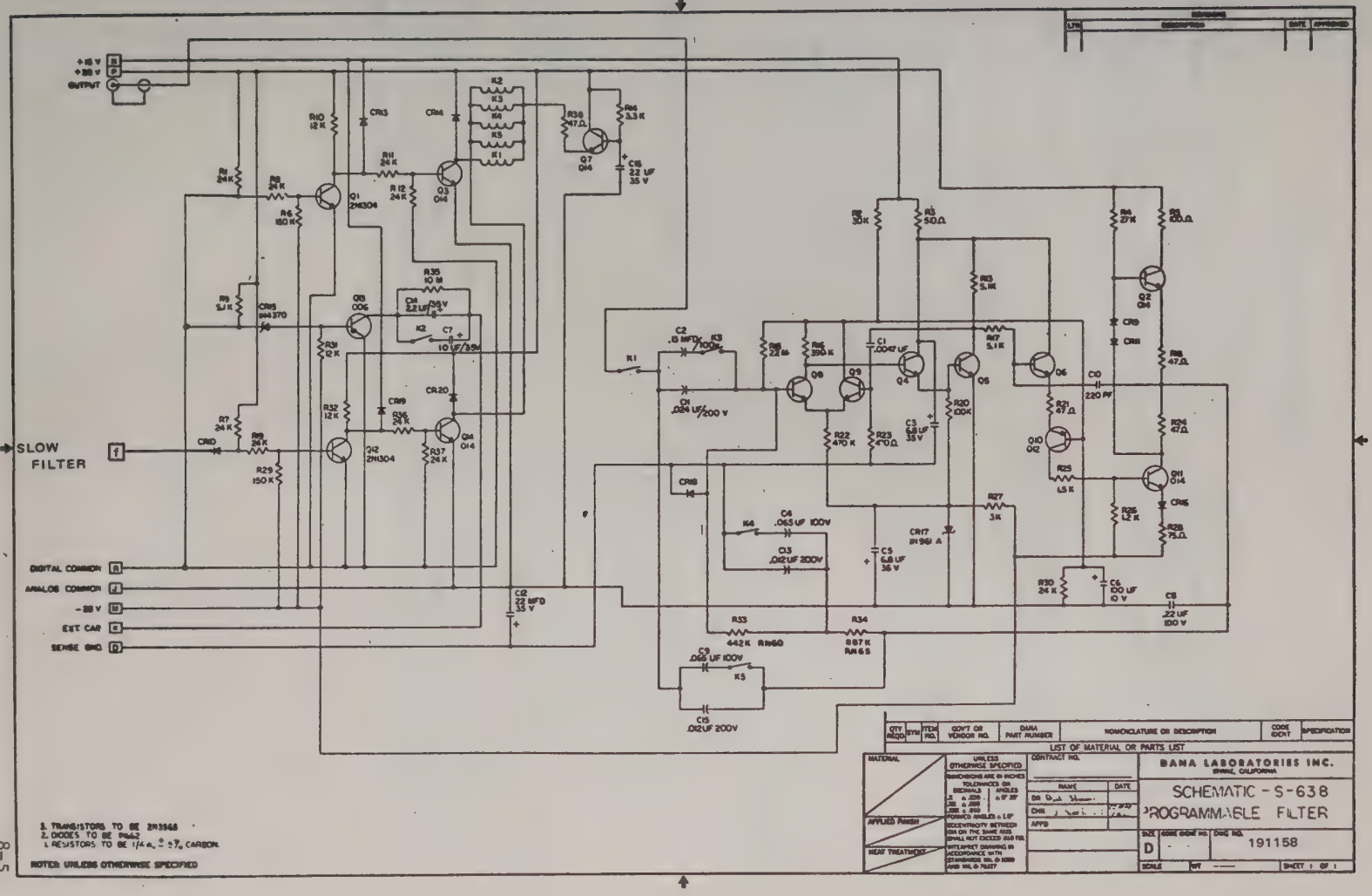
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C. BOARD ASSY, PROGRAMMABLE FILTER

SIZE	CODE IDENT NO.	DWG. NO.
D		191157

SCALE 2/1 | WT | SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED


+15 V
+30 V
OUTPUT
SLOW FILTER
DIGITAL COMMON
ANALOG COMMON
-30 V
EXT CAP
SENSE GND
Q1 2N3304
Q2 2N3304
Q3 014
Q4 014
Q5 006
Q6 Q10 Q2
Q7 014
Q8 Q9
Q11 014
K1
K2
K3
K4
K5
C1 .0047 UF
C2 .15 MFD 100V
C3 .012 UF 200V
C4 .065 UF 100V
C5 6.8 UF 35 V
C6 100 UF 10 V
C7 10 UF/35V
C8 22 MFD 35 V
C9 .065 UF 100V
C10 220 PF
C11 .22 UF 100 V
C12 .024 UF/200 V
C15 .012 UF 200V
C16 22 UF 35 V
CR17 IN 961 A
R33 442 K RN60
R34 887 K RN65
NOTES: UNLESS OTHERWISE SPECIFIED
1. TRANSISTORS TO BE 2N3968
2. DIODES TO BE IN62
3. RESISTORS TO BE 1/4 w, 5 ±5% CARBON
LIST OF MATERIAL OR PARTS LIST
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC - S-638
PROGRAMMABLE FILTER
191158
SHEET 1 OF 1

HIGH VOLTAGE PROBE

The Dana High Voltage Probe assembly is installed in place of the DVM standard input signal cable to obtain AC or DC voltage measurements directly in kilovolts. The assembly consists of the cable, the probe itself, and a calibration box containing the AC/DC selector switch and separate AC and DC trimming resistors.

Size of Probe:	Approximately 14" long, supplied with Corona shield.
AC and DC Specifications:	
Input Impedance	100 megohms $\pm$1% shunted by less than .5pF.
Divider Ratio	1.000:1
Stability - 30 days	.05%
Accuracy - Resolution	Can be adjusted to within .01% of standard. (Adjustments located on input connector.)
Frequence Response:	Within .5% from 50 - 400 Hz. (Adjustment located on input connector.)
Voltage Coefficient:	Less than .1 ppm/volt.
Temperature Coefficient:	Less than 25 ppm/^{o}C

Two AC ranges are available: 1000 volts full scale or 10,000 volts full scale. This feature allows high resolution measurements below 1000 volts. The use of a probe is desirable, when measuring high voltage AC, in that the capacity is drastically reduced.

DANA MODEL 5600-S-722

HIGH VOLTAGE PROBE

ADJUSTMENT

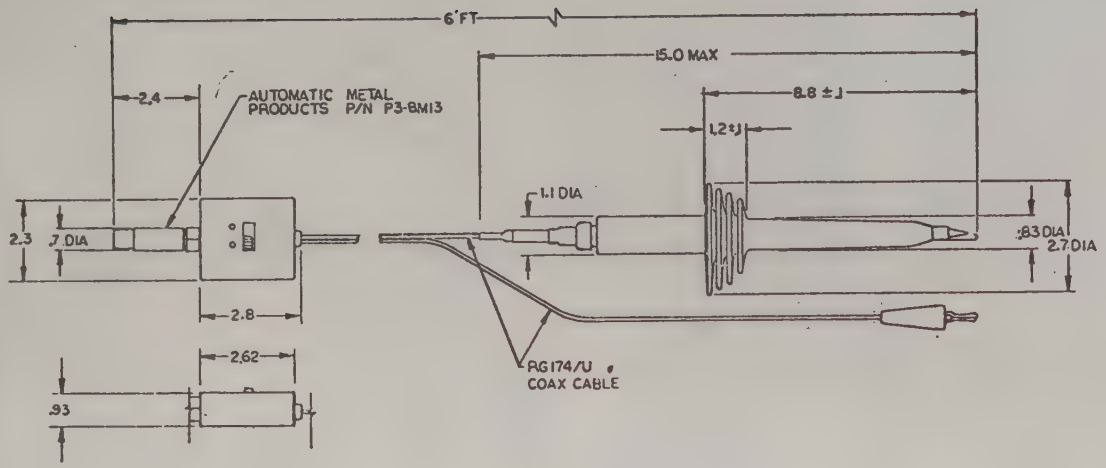
DC Adjustment:

1. Set RANGE switch on DVM to either AUTO or 10 volt range; FUNCTION to DC.
2. Connect High Voltage probe assembly to input connector.
3. Place AC/DC switch on Calibration Box to DC.
4. Connect High Voltage probe to a source of 9.5kV, DC.
5. Adjust R4 (DC trimmer) for 9.5000 reading on DVM display (reading is directly in kV).

AC Adjustment:

1. Set RANGE switch on DVM to either AUTO or 10 volt range; FUNCTION to AC.
2. Connect High Voltage probe assembly to input connector.
3. Place AC/DC switch on Calibration Box to AC.
4. Connect High Voltage probe to a source of 2.45kV, 300Hz.
5. Adjust R6 (AC trimmer) for reading of 2.4500 on DVM display.

LTR	DESCRIPTION	DATE	APPROVED



QTY REQD	SYM	ITEM NO.	GOV'T OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS: .X ± .030; .XX ± .020; .XXX ± .010; ANGLES ± 0° 30'
FORMED ANGLES ± 1.0°
ECCENTRICITY BETWEEN DIA ON THE SAME AXIS SHALL NOT EXCEED .010 TIR.
INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL-D-1000 AND MIL-D-70327

CONTRACT NO.

	NAME	DATE
DR		
CHK		
APPD.		

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

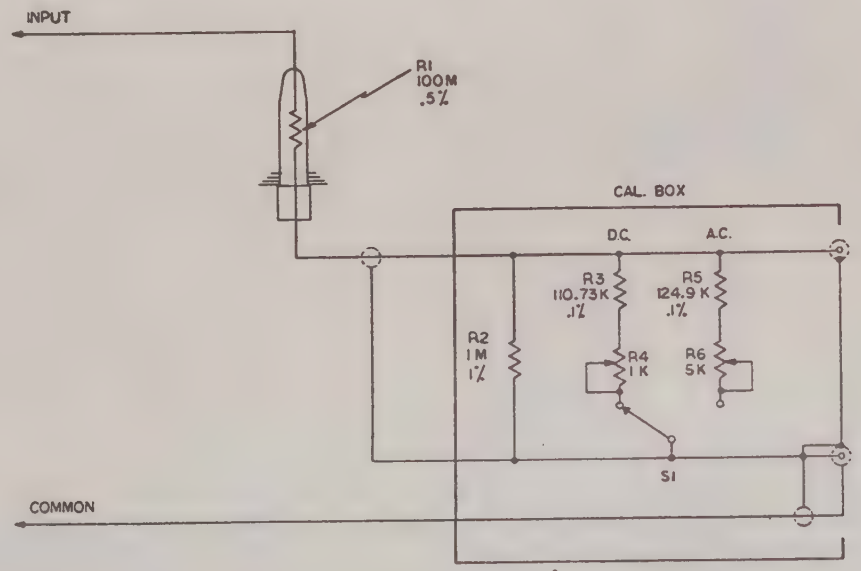
DIM. OUTLINE
MODEL 640-S-722

SIZE	CODE IDENT NO.	DWG NO.
C	———	190158

SCALE NONE | WT ——— | SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



QTY REQD	SYM	ITEM NO.	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

MATERIAL

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES

TOLERANCES ON DECIMALS: .X ± .030, .XX ± .020, .XXX ± .010; ANGLES ± 0° 30'

FORMED ANGLES ± 1.0°

ECCENTRICITY BETWEEN DIA ON THE SAME AXIS SHALL NOT EXCEED .010 TIR.

INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL-D-1000 AND MIL-D-70327

CONTRACT NO.

NAME	DATE
DR W. Eoff	11 Apr. 1966
CHK D Payne	4/18/66
APPD J. Hilton	4/18/66

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC – HIGH VOLTAGE PROBE MODEL 640

SIZE	CODE IDENT NO.	DWG NO.
C	—	430402

SCALE — | WT — | SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED

MODEL 11 PREAMPLIFIER

1.0 INTRODUCTION

The Model 11 DC Preamplifier increases the sensitivity of Dana Digital Voltmeters by decreasing the DC Voltage ranges by a factor of 1000. The output is then read as "millivolts" rather than volts. (On Series 5600 Digital Voltmeters, the "1" range is not used for millivolt measurements.)

All preamplifier circuitry is mounted on a single plug-in circuit board that can be installed in its prewired position within the DVM at any time. Solid-state components are used throughout except for a mechanical modulator. The three ranges are factory set for maximum accuracy; long-term stability is assured by the use of premium, highly stable feedback resistors. No preliminary adjustments or periodic calibration is necessary. However, a zeroing control is provided to compensate for thermal potentials generated in particular test setups.

2.0 SPECIFICATIONS

Full Scale:	On 5600 DVM's: 9.9999, 99.999, & 999.99 millivolts On 5700 DVM's: 10.9999, 109.999, and 1099.99 millivolts
Accuracy:	±0.02% of reading or ±0.01% of f.s.
Zero stability:	1 microvolt for 200 hours at constant temperature (after 30 minutes warm-up).

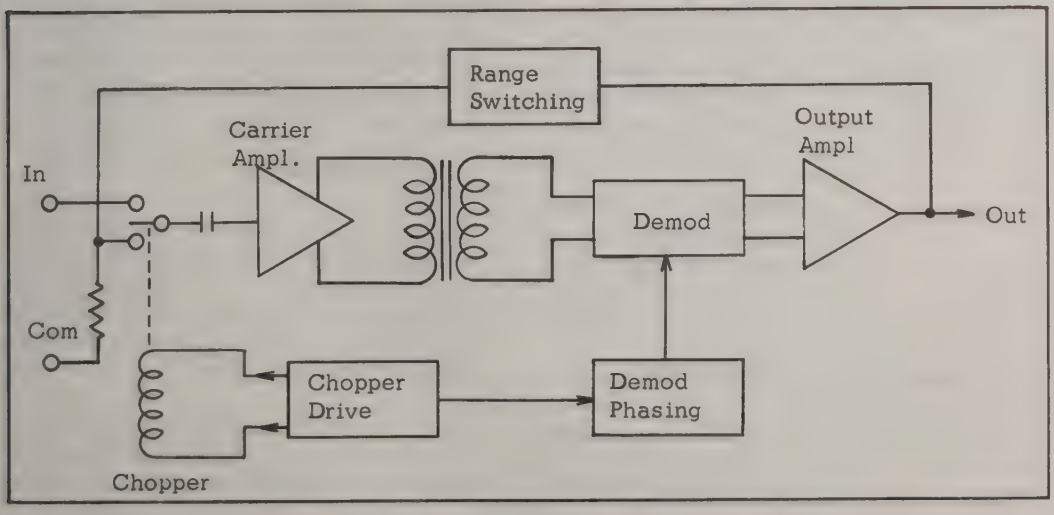


Figure 1. Model 11 Preamplifier

SPECIFICATIONS (Cont)

Response time (to 0.01%)	
Step response:	1 second
Response with range change:	3 seconds
Input resistance:	100 megohms minimum
Common Mode Rejection, dc to 60 Hz	at least 130 db with up to 1000 ohms in either lead
Resolution on most sensitive range:	0.1 microvolt per digit
Range Control:	Automatic (manual override), selected by DVM front panel control
Decimal Point Indication:	Automatic; displayed in millivolts
Measuring Time:	DC voltage measuring time plus 1 second on fixed range and polarity; DC measuring time plus three seconds worst case polarity and range change
Isolation:	Preamplifier input is isolated and guarded from GND, AC power line and electrical output

3.0 OPERATIONAL DESCRIPTION

A simplified diagram of the preamplifier is shown in Figure 1. The input voltage is applied to a 400 Hz chopper. The voltage, modulated at 400 Hz, is applied to an AC carrier amplifier which delivers a current proportional to the voltage input. The output of the carrier amplifier is transformer-coupled to a demodulator. The demodulator operates on the principle of a full-wave rectifier. Each side of the secondary of the demodulator transformer is connected to the emitter of one of a pair of transistors. A 400-Hertz signal from the Chopper Drive oscillator is applied to the bases. The transistors are turned on alternately with the DC output taken between the common collectors and the transformer secondary center tap.

The demodulated signal is sent to the DC output amplifier. The amplifier output is applied back to the input through relay-operated range switches. The relays are energized by the range control signals (R1, R2, R2) generated by manual range selection or by a decision of the Auto Range circuit within the DVM.

The Chopper drive signal is generated by a 400 Hz oscillator and applied to the chopper drive coils. The same 400 Hz signal drives the Demodulator Phasing circuits. The demodulator phasing circuits phase the demodulator signals with the chopper (modulator) so that the demodulated signal corresponds to the unmodulated DC input.

4.0 OPERATION

Millivolt measurements are made using the normal input leads and the operation of the DVM is much the same as for standard DC measurements, since the normal guarded input circuit, and all automatic features are available.

To activate the preamplifier, the function switch is placed in the Millivolt position. Automatic ranging may then be selected

as in standard DC operation, or if desired, the instrument may be manually placed on the 10, 100, or 1000 millivolt position. The 1 millivolt range is not operational for millivolt measurements in the 5600 Series DVM's.

Either standard mode position may be selected when measuring millivolts; however, they will react, or in some cases appear to react, somewhat differently. These differences are described below.

Periodic

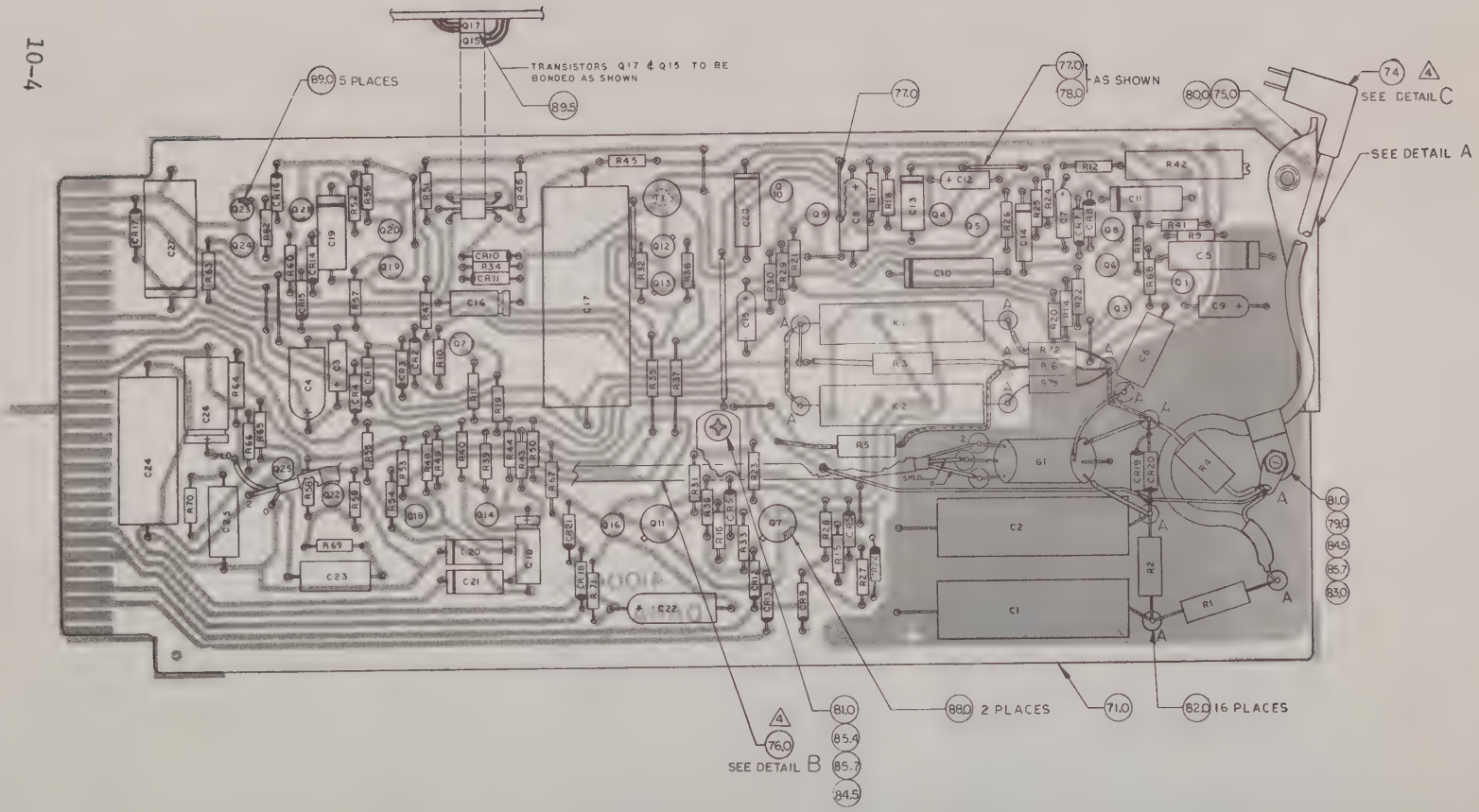
When polarity and range changes are not required, operation will be normal and periodic measurements will be made at the repetition rate determined by the specific DVM in use; however, when a range or polarity change occurs, the "time out" circuits in the DVM (set for approximately 1.0 second for Millivolts), will inhibit read commands to permit the preamplifier to settle and avoid erroneous readings.

Tracking

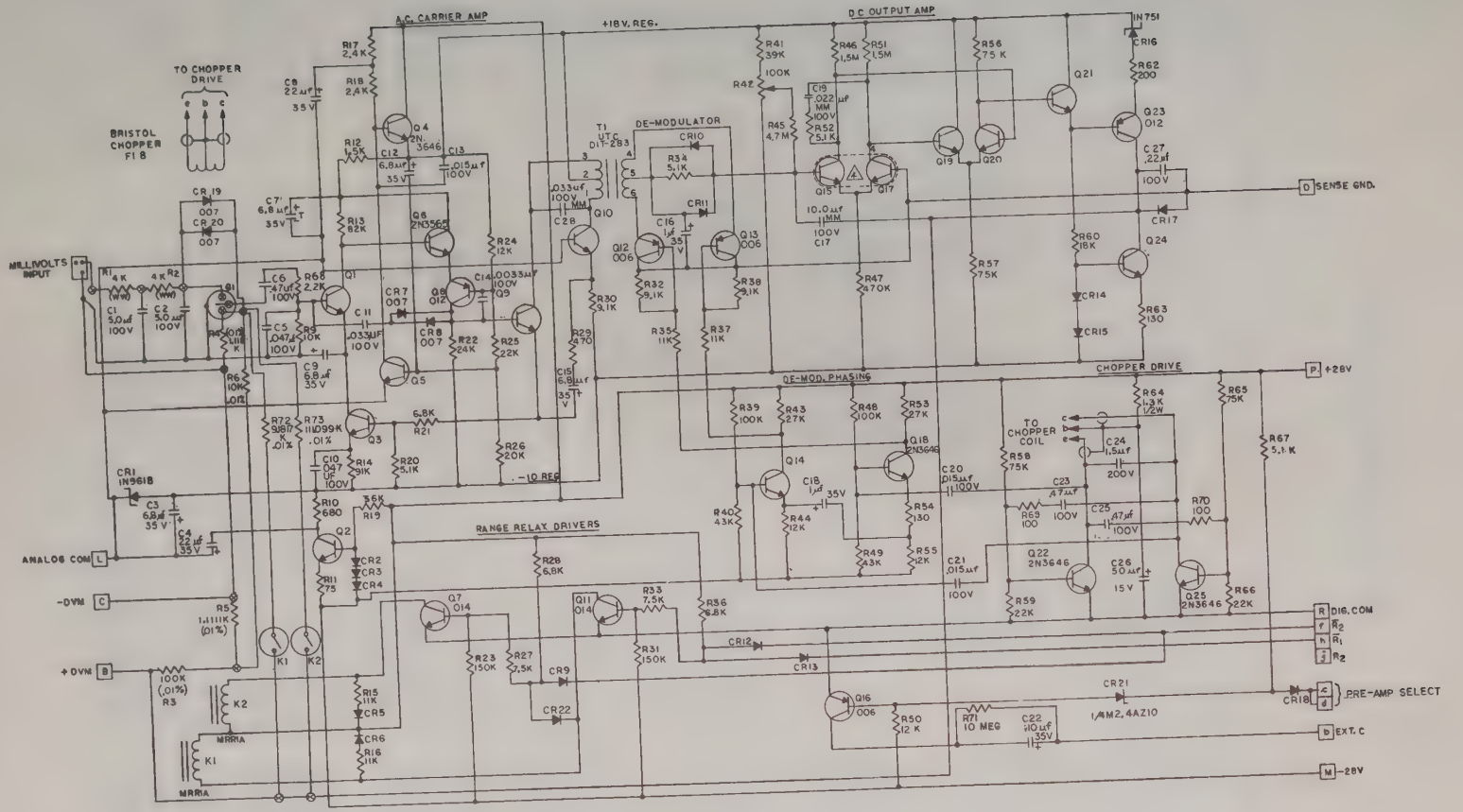
In Tracking mode, the DVM will track the input signal as described in the DVM instruction manual. If the input voltage shifts more than one digit for the duration of the variable sensing period, a new reading will be taken.

5.0 CALIBRATION

The Preamplifier is factory adjusted for minimum offset. However, the operator may wish to readjust the zero control occasionally to compensate for thermal potentials generated in a given test set-up. The ZERO control is located on the front of the Preamplifier, readily accessible behind the right front panel of the Digital Voltmeter. The board is located in the fifth board position from the extreme right in 5600 Series DVM's and in the second position from extreme left in 5700 series instruments. The zero adjustment should be made only after the DVM and all associated input circuits have achieved thermal stability. The Model 11 was designed for on-the-line applications and is as foolproof as is consistent with performance requirements. Fusing being impractical due to thermal problems, the instrument was designed to withstand sustained overloads up to 10 volts. Although higher voltages can be tolerated for short periods of time, the operator should exercise care to see that the 10 volt rating is not exceeded.



Assembly - Model 11 Preamplifier



Schematic - Model 11 Preamplifier

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
C1	120016	CAP	MYLAR	5 MFD 100 V 10%	IMB	XA1133K
C2	120016	CAP	MYLAR	5 MFD 100 V 10%	IMB	XA1133K
C3	110001	CAP	TANTA	6.8 MFD 35 V 10%	KEMET	K6R8C35K
C4	110002	CAP	TANTA	22 MFD 35 V 10%	KEMET	K22C35K
C5	121093	CAP	MYLAR	.047 MFD 100 V 10%	CDE	WMF1S47
C6	120096					
C7	110001	CAP	TANTA	6.8 MFD 35 V 10%	KEMET	K6R8C35K
C8	110002	CAP	TANTA	22 MFD 35 V 10%	KEMET	K22C35K
C9	110001	CAP	TANTA	6.8 MFD 35 V 10%	KEMET	K6R8C35K
C10	121093	CAP	MYLAR	.047 MFD 100 V 10%	CDE	WMF1S47
C11	121091	CAP	MYLAR	.033 MFD 100 V 10%	CDE	WMF1533
C12	110001	CAP	TANTA	6.8 MFD 35 V 10%	KEMET	K6R8C35K
C13	121090	CAP	MYLAR	.015 MFD 100 V 10%	CDE	WMF1S15
C14	120001	CAP	MYLAR	.0033 MFD 100 V 10%	CDE	WMF1D33
C15	110001	CAP	TANTA	6.8 MFD 35 V 10%	KEMET	K6R8C35K
C16	110017	CAP	TANTA	1 MFD 35 V 10%	KEMET	K1C35K
C17	120020	CAP	MYLAR	10 MFD 100 V 10%	IMB	XA2B10C
C18	110017	CAP	TANTA	1 MFD 35 V 10%	KEMET	K1C35K
C19	121468	CAP	MYLAR	.022 MFD 100 V 10%	CDE	WMF1S22
C20	121090	CAP	MYLAR	.015 MFD 100 V 10%	CDE	WMF1S15
C21	121090	CAP	MYLAR	.015 MFD 100 V 10%	CDE	WMF1S15
C22	110020	CAP	TANTA	10 MFD 35 V 10%	KEMET	K10C35K
C23	120096					
C24	120025	CAP	MYLAR	1.5 MFD 100 V 10%	IMB	XA2B1551C
C25	120096					
C26	111096	CAP	ELECT	50 MFD 15 V 20%	SPRAGUE	TE1160
C27	121393	CAP	MYLAR	.22 MFD 100 V 10%	CDE	WMF1P22
C28	121091	CAP	MYLAR	.033 MFD 100 V 10%	CDE	WMF1533
CR1	220004	DIODE	SILICO ZENER	1N961B	MOTOROLA	1N961B
CR2	211083	DIODE	SILICO	018	DANA	211083
THRU						
CR18	211083	DIODE	SILICO	018	DANA	211083
CR19	211236					
CR20	211236					
CR21	221177	DIODE	SILICO ZENER	1/4 W	MOTOROLA	M.2.4A25
G1	310005	RELAY	CHOP	SPDT 400C	BRISTOL	F38
K1	310024	RELAY	REED	SPST 24V	DANA	310024
K2	310024	RELAY	REED	SPST 24V	DANA	310024
Q1	200048	TRANS	SILICO NPN DUAL	2N3565		
Q2	200048	TRANS	SILICO NPN DUAL	2N3565		

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
R19	000563	RES	CARBON	56 K	5%	1/4 W	OHMITE	RC07GF563J
R20	000512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J
R21	000682	RES	CARBON	6.8 K	5%	1/4 W	OHMITE	RC07GF682J
R22	000243	RES	CARBON	24 K	5%	1/4 W	OHMITE	RC07GF243J
R23	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R24	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R25	000223	RES	CARBON	22 K	5%	1/4 W	OHMITE	RC07GF223J
R26	000203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R27	000752	RES	CARBON	7.5 K	5%	1/4 W	OHMITE	RC07GF752J
R28	C00682	RES	CARBON	6.8 K	5%	1/4 W	OHMITE	RC07GF682J
R29	000471	RES	CARBON	470 OHM	5%	1/4 W	OHMITE	RC07GF471J
R30	000912	RES	CARBON	9.1 K	5%	1/4 W	OHMITE	RC07GF912J
R31	000154	RES	CARBON	150 K	5%	1/4 W	OHMITE	RC07GF154J
R32	000912	RES	CARBON	9.1 K	5%	1/4 W	OHMITE	RC07GF912J
R33	000752	RES	CARBON	7.5 K	5%	1/4 W	OHMITE	RC07GF752J
R34	000512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J
R35	000113	RES	CARBON	11 K	5%	1/4 W	OHMITE	RC07GF113J
R36	000682	RES	CARBON	6.8 K	5%	1/4 W	OHMITE	RC07GF682J
R37	000113	RES	CARBON	11 K	5%	1/4 W	OHMITE	RC07GF113J
R38	000912	RES	CARBON	9.1 K	5%	1/4 W	OHMITE	RC07GF912J
R39	000104	RES	CARBON	100 K	5%	1/4 W	OHMITE	RC07GF104J
R40	000433	RES	CARBON	43 K	5%	1/4 W	OHMITE	RC07GF433J
R41	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J
R42	040004	RES	VARI	100 K	10U	1/5 W	BOURNS	3068-P-1-104
R43	000273	RES	CARBON	27 K	5%	1/4 W	OHMITE	RC07GF273J
R44	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R45	000475	RES	CARBON	4.7 M	5%	1/4 W	OHMITE	RC07GF475J
R46	000155	RES	CARBON	1.5 M	5%	1/4 W	OHMITE	RC07GF155J
R47	000474	RES	CARBON	470 K	5%	1/4 W	OHMITE	RC07GF474J
R48	000104	RES	CARBON	100 K	5%	1/4 W	OHMITE	RC07GF104J
R49	000433	RES	CARBON	43 K	5%	1/4 W	OHMITE	RC07GF433J
R50	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R51	000155	RES	CARBON	1.5 M	5%	1/4 W	OHMITE	RC07GF155J
R52	000512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J
R53	000273	RES	CARBON	27 K	5%	1/4 W	OHMITE	RC07GF273J
R54	000131	RES	CARBON	130 OHM	5%	1/4 W	OHMITE	RC07GF131J
R55	000123	RES	CARBON	12 K	5%	1/4 W	OHMITE	RC07GF123J
R56								
R57	C00753	RES	CARBON	75 K	5%	1/4 W	OHMITE	RC07GF753J
R58	000753	RES	CARBON	75 K	5%	1/4 W	OHMITE	RC07GF753J

REF DES	DANA P/N	PART	TYPE	DESCRIPTION	MANUFAC	MANUFAC P/N
Q3	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q4	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q5	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q6	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q7	200035	TRANS	SILICO	NPN 014	DANA	200035
Q8	200022	TRANS	SILICO	PNP 012	DANA	200022
Q9	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q10	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q11	200035	TRANS	SILICO	NPN 014	DANA	200035
Q12	201111	TRANS	GERMAN	PNP 006	DANA	201111
Q13	201111	TRANS	GERMAN	PNP 006	DANA	201111
Q14	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q15	200024	TRANS	SILICO	NPN DUAL 2N3707	DANA	200024
Q16	201111	TRANS	GERMAN	PNP 006	DANA	201111
Q17	200024	TRANS	SILICO	NPN DUAL 2N3707	DANA	200024
Q18	200037	TRANS	SILICO	NPN 2N3646	FAIRCHILD	2N3646
Q19	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q20	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q21	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q22	200037	TRANS	SILICO	NPN 2N3646	FAIRCHILD	2N3646
Q23	200022	TRANS	SILICO	PNP 012	DANA	200022
Q24	200048	TRANS	SILICO	NPN DUAL 2N3565		
Q25	200037	TRANS	SILICO	NPN 2N3646	FAIRCHILD	2N3646
R1	020058	RES	WW	4 K 3% 1/4 W	JORDAN	J-12
R2	020058	RES	WW	4 K 3% 1/4 W	JORDAN	J-12
R3	021398	RES	WW	100 K .01% 1/4 W	JORDAN	J-12
R4	020057	RES	WW	1.1111 K .01% 1/4 W	JORDAN	J-12
R5	020057	RES	WW	1.1111 K .01% 1/4 W	JORDAN	J-12
R6	020363					
R	000101	RES	CARBON	100 OHM 5% 1/4 W	OHMITE	RC07GF101J
R10	000681	RES	CARBON	680 OHM 5% 1/4 W	OHMITE	RC07GF681J
R11	000750	RES	CARBON	75 OHM 5% 1/4 W	OHMITE	RC07GF750J
R12	000152	RES	CARBON	1.5 K 5% 1/4 W	OHMITE	RC07GF152J
R13	000823	RES	CARBON	82 K 5% 1/4 W	OHMITE	RC07GF823J
R14	000913	RES	CARBON	91 K 5% 1/4 W	OHMITE	RC07GF913J
R15	000113	RES	CARBON	11 K 5% 1/4 W	OHMITE	RC07GF113J
R16	000113	RES	CARBON	11 K 5% 1/4 W	OHMITE	RC07GF113J
R17	000242	RES	CARBON	2.4 K 5% 1/4 W	OHMITE	RC07GF242J
R18	000242	RES	CARBON	2.4 K 5% 1/4 W	OHMITE	RC07GF242J

REF DES	DANA P/N	PART	TYPE	DESCRIPTION			MANUFAC	MANUFAC P/N
R59	000223	RES	CARBON	22 K	5%	1/4 W	OHMITE	RC07GF223J
R60	000183	RES	CARBON	18 K	5%	1/4 W	OHMITE	RC07GF183J
R62	000201	RES	CARBON	200 OHM	5%	1/4 W	OHMITE	RC07GF201J
R63	000131	RES	CARBON	130 OHM	5%	1/4 W	OHMITE	RC07GF131J
R64	001686	RES	CARBON	1.3 K	5%	1/2 W	OHMITE	RC20GF132J
R65	000753	RES	CARBON	75 K	5%	1/4 W	OHMITE	RC07GF753J
R66	000223	RES	CARBON	22 K	5%	1/4 W	OHMITE	RC07GF223J
R67	000512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J
R68	000222	RES	CARBON	2.2 K	5%	1/4 W	OHMITE	RC07GF222J
R69	000101	RES	CARBON	100 OHM	5%	1/4 W	OHMITE	RC07GF101J
R70	000101	RES	CARBON	100 OHM	5%	1/4 W	OHMITE	RC07GF101J
R71	000105	RES	CARBON	1 M	5%	1/4 W	OHMITE	RC07GF105J
T11	300001							

6.0 TROUBLESHOOTING

Functionally check the operation of the DC Preamplifier by measuring known voltages on each range. Refer to list below for aid in isolating malfunctions.

1. Output Random Numbers
   (a) Check regulated power supplies (+18 and -10).
   (b) Check chopper drive (Q22 and Q25). (See Figure 2)
   (c) Check De-modulation Phasing (Q14 and Q18) (Figure 3)
2. Abnormal Reading on All Ranges
   (a) Place DVM in HOLD position and apply approximately 1.5 volts to input. Monitor junction of C6 and chopper arm for a symmetrical chopper wave form (Figure 4)
   (b) Check transistor Q1, Q23, and Q24
3. Abnormal Reading on 100mv Range
   (a) Check K2 and associated driver circuitry
4. Abnormal Readings on 1000mv Range
   (a) Check K1 and associated driver circuitry

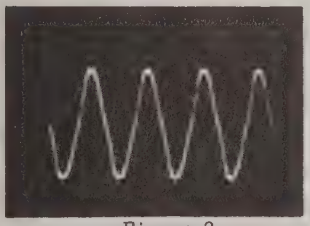


Figure 2

Figure 3

Figure 4

11.1 SCOPE OF MAINTENANCE

11.2. The maintenance duties assigned to operator and organizational repairman of this equipment are listed below with a reference to the paragraphs covering the specific maintenance functions. The preventive maintenance procedures require no special tools or test equipment.

a. Daily preventive maintenance checks and services (para. 11.8).
b. Weekly preventive maintenance checks and services (para. 11.9).
c. Monthly preventive maintenance checks and services (para. 11.10).
d. Quarterly preventive maintenance checks and services (para. 11.13).
e. Cleaning (para. 11.16).
f. Touchup painting instructions (para. 11.18).

11.3 MATERIALS REQUIRED FOR MAINTENANCE

a. Trichloroethane (6810-292-9625).

WARNING

The fumes of trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but exposure of the fumes to an open flame converts the fumes to highly toxic, dangerous gases.

b. Cleaning cloth.
c. Fine sandpaper.
d. Touchup paint.

11.4 PREVENTIVE MAINTENANCE

11.5. Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedure given in paragraphs 11.6 through 11.19 covers routine systematic care and cleaning essential to proper upkeep and operation of the equipment.
b. Preventive Maintenance Checks and Services. The maintenance checks and services charts outline function to be performed at specific intervals. These checks and services are to maintain equipment in a combat serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and the normal conditions. The reference column lists the paragraphs that contain additional information. If the defect cannot be found by performing the corrective action indicated, a higher category of maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

11.6 PREVENTIVE MAINTENANCE CHECKS AND SERVICES PERIODS

11.7. Preventive maintenance checks and services of this equipment are required daily, weekly, monthly, and quarterly. Daily maintenance checks and services are specified in paragraph 11.8. Paragraph 11.9. specifies checks and services that must be performed weekly. If the equipment is maintained in a standby condition, the daily and weekly checks should be accomplished at the same time. The maintenance checks and services that are accomplished monthly are specified in paragraph 11.11. Quarterly maintenance checks and services are specified in paragraph 11.14.

11.8. DAILY PREVENTIVE MAINTENANCE CHECKS AND SERVICES CHART

Sequence No.	Items to be inspected.	Procedure	Reference
1	Completeness	See that the equipment is complete	Appendix,
2	Cleanliness	Exterior of equipment must be clean and dry, free of fungus, dirt, dust, and grease.	Paragraph 11.16
3	Operational check.	Check the operational efficiency	
4	Controls	See that controls operate smoothly and are fastened in place securely.	

11.9. WEEKLY PREVENTIVE MAINTENANCE AND SERVICES CHART

Sequence No.	Items to be inspected.	Procedure	Reference
1	Cables	Inspect cards and cables for chafed, cracked, or frayed insulation. Replace connectors that are broken, stripped, or worn.	
2	Metal surfaces	Inspect exposed metal surface for rust and corrosion. Clean and touchup with paint as required.	Paragraphs 11.16 and 11.18

11.10 MONTHLY MAINTENANCE

11.11. Perform the maintenance functions indicated in the monthly preventive maintenance checks and services chart (para. 11.12) once each month. Periodic daily (para. 11.8) and weekly (para. 11.9) services constitute a part of the monthly checks.

11.12 MONTHLY PREVENTIVE MAINTENANCE CHECKS AND SERVICES CHART

Sequence No.	Items to be inspected	Procedure
1	Terminations	Inspect for loose connections and cracked or broken insulation.
2	Control panel	Clean panel thoroughly and check all surfaces for chips, cracks, and abnormal wear.
3	Hardware	Inspect all hardware for possible damage.
4	Air filter	Remove air filter, clean, and replace.

11.13 QUARTERLY MAINTENANCE

11.14. Quarterly preventive maintenance checks and services are required for this equipment. Periodic daily, weekly, and monthly services constitute a part of the quarterly preventive maintenance checks and services and must be performed concurrently. All deficiencies or shortcomings will be recorded in accordance with the requirements of TM 38-750. Perform all the checks and services listed in the quarterly preventive maintenance checks and services chart (para. 11.15) in the sequence listed. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions.

11.15. QUARTERLY PREVENTIVE MAINTENANCE CHECKS AND SERVICES CHART

Sequence No.	Items to be inspected.	Procedure	Reference
1	Publications	See that all publications are complete, serviceable, and current.	DA Pam 310-4
2	Modifications	Check DA Pam 310-7 to determine whether new applicable MWO's have been published. All URGENT MWO's must be applied immediately All normal MWO's must be scheduled.	TM 38-750 and DA Pam 310-7,

11.16 CLEANING

11.17. Inspect the exterior surfaces. The surfaces must be free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean, soft cloth.

b. Remove grease, fungus, and ground-in dirt. Use a damp cloth (not wet) with trichloroethane to clean terminations. If dirt on the body of the unit is difficult to remove, use mild soap and water.

c. Remove dust or dirt from the jacks and plugs with a brush.

11.18 TOUCHUP PAINTING INSTRUCTIONS

11.19. Remove dust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to applicable cleaning and refinishing practices specified in TB 746-10.

APPENDIX A

RATIO MEASUREMENT TECHNIQUES

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RATIO-MEASUREMENT TECHNIQUES

INTRODUCTION

A great many voltage measurements have, as their basic objective, the comparison or ratio of two voltages. This is true, particularly, in the testing of devices such as amplifiers and transformers, which generate a transfer function. The absolute values of the input and output voltages are not as important as the ratio between the two. Similarly, when devices such as vibration transducers are tested against a standard transducer, the objective is to develop a calibration factor or ratio between the two outputs.

The measurement of the ratio as a calculated value derived from two absolute voltage measurements is time consuming, subject to operator error, and most important, is limited in accuracy by the stability of the energy source. All of these objections are eliminated by the use of a ratiometer which detects both voltages simultaneously and produces a ratio value in real time.

Such an instrument makes it possible to measure ratios rapidly and under dynamic conditions. The transfer function of a device may be examined as a function of input voltage, frequency, and time, in a single series of measurements, by varying the amplitude and signal frequencies across the desired ranges and recording the data at precise intervals to detect any time drift due to such factors as self heating. Time intervals between absolute measurements would tend to mask such drift characteristics.

Ratiometers to perform measurements like these should ideally have the following characteristics:

1. A real-time ratio-taking capability.
2. The ability to measure ac/ac, ac/dc, and dc/ac ratios, as well as the more usual dc/dc ratios.
3. Phase independence in the case of ac/ac measurements.

4. High input impedances for both the signal (numerator) and reference (denominator).
5. Fast digitizing time.
6. High accuracy, ideally higher than that obtained in taking absolute measurements against an internal reference.

Instruments of this type are relatively new. The purpose of this paper is to examine their use and to summarize the instrumentation techniques that may be employed to enhance their performance.

RATIOMETER DESIGN

Figure 1 presents a simplified block diagram of a general-purpose ratiometer of the null-balance type.

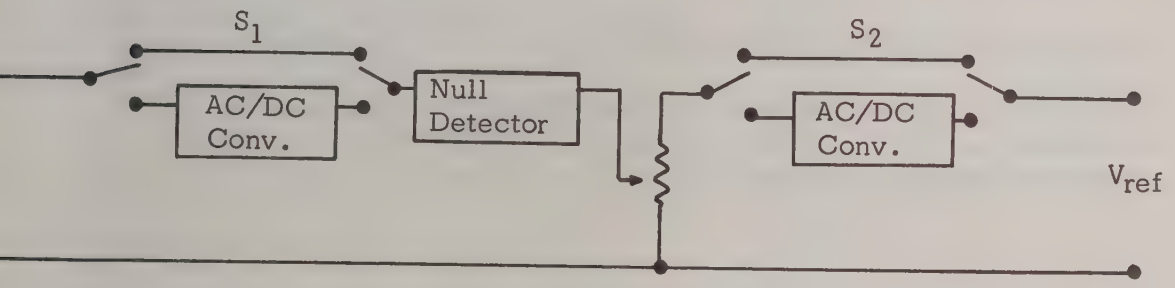


FIGURE 1.

By appropriate operation of switches S_1 and S_2, ratio combinations such as ac/ac, ac/dc, dc/ac, and dc/dc may be performed. To make ac/ac measurements, two ac converters are required. The desired characteristics of the ac converters is that their frequency response and settling time be similar for those conditions where f_{in} equals f_{ref} and that their frequency response be flat for the cases when the two frequencies are not equal.

AC converters for ratiometer use are designed to have fast and similar settling times in order to reject to a high degree oscillator amplitude modulation and converter ripple. Stable, uniform converters with high ac resolution make it possible to take ac/ac ratio measurements to

an accuracy of 0.03% even when the individual converter has an accuracy specification of only 0.1%

The null detector in Figure 1 must have high sensitivity and low noise, if it is to operate over a wide range of reference voltages. If we assume a 5 decade instrument with a nominal 10 volt reference, one digit represents 100 μ volts. If the reference voltage is decreased to 1 v, one digit represents a 10 μ volt change in the input signal.

To operate over a wide range of reference voltages, then the null detector must have a gain control in order to achieve stability if the logic is of a tracking type or the gain will be low and errors will occur for low reference voltages. However, if the logic is of the successive approximation type, that is, each reading is a separate and complete reading and does not rely on an absolute null to be stable, the gain can, in theory, be made infinitely large. The limiting factor now is noise.

THREE-WIRE RATIO MEASUREMENTS

Three-wire ratio measurements will be affected by the ref input impedance, as will be shown. Figure 2 shows typical ground connections in a three-wire setup.

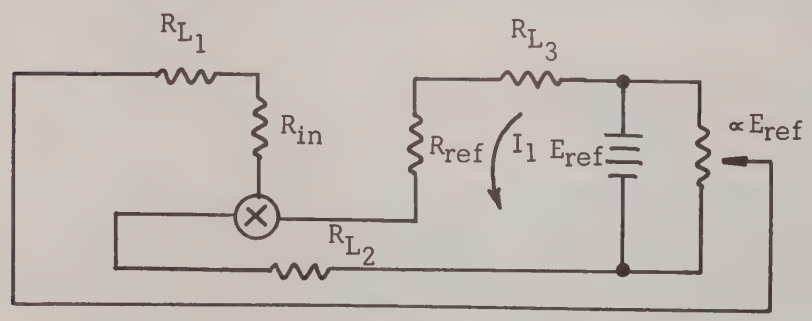


FIGURE 2.

R_{in} is the input resistance of the ratiometer
R_{ref} is the reference input resistance of the ratiometer
R_{L_1}, R_{L_2}, R_{L_3}, are lead resistances
Ⓧ = DVM common

The true reference voltage as seen by the ratiometer appears across R_{ref}. Voltage drop in R_{L_2} and R_{L_3} is subtracted from E_{ref} causing an error in the reference voltage seen by R_{ref}. The drop across R_{L_2} also appears as an input signal and is constant for a given reference and input leads.

To examine the magnitude of the errors possible, assume RG-174 cable, a 10 volt reference, and 50,000 ohms for R_{ref}. Assume an 8-foot input cable.

RG-174 cable is approximately 100 milliohms/foot.

Let

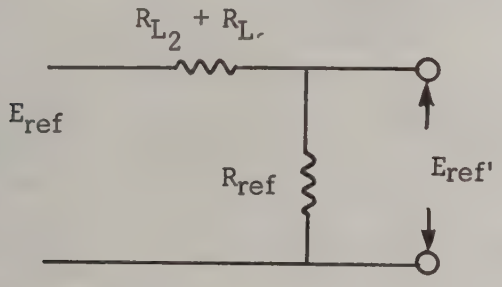
$$R_{L_1} = R_{L_2} = R_{L_3} = 800 \text{ milliohms}$$

$$I_1 = \frac{E_{ref}}{R_{ref}} = \frac{10}{50} \times 10^{-3} = \underline{\underline{0.2 \text{ ma}}}$$

$$E_{L_2} = 0.8 \ (\times 2 \times 10^{-4}) = 0.16 \times 10^{-4} = 160 \ \mu \text{ volts}$$

E_{L_2} appears as an offset to the input and is equal to 16 ppm of FS

Reference Equivalent Circuit:



$$E_{ref'} = E_{ref} \left(\frac{R_{ref}}{R_{ref} + R_{L_2} + R_{L_3}} \right)$$

$$\text{error in } E_{ref} = E_{ref} - E_{ref'} = \left(1 - \frac{R_{ref}}{R_{ref} + R_{L_2} + R_{L_3}} \right)$$

$$\text{for above case, \% error} = \frac{160}{5 \times 10^4} = 0.0032\%$$

Therefore, 8 feet of RG-174 input cable and a reference input resistance of 50,000 ohms will cause a 0.0032% of reading error and 0.0016% of FS error.

At full scale, these effects are subtractive, since the reference voltage is 0.0032% low, causing the reading to be 0.0032% high, and the 0.0016% of FS appears as an offset in the negative direction for a positive reference. The total error at full scale is 0.0016%.

However, at 10% of full scale, the percent of reading error becomes insignificant and the percent of full scale dominates. The percent of reading error is now 0.016%.

The offset voltage due to lead resistance in R_{L_2} is the more serious error offender. It is, therefore, desirable to keep current I_1 to a minimum value by maintaining a large value of R_{ref}.

Figure 3 shows a setup to accomplish this within the ratiometer by the addition of a buffer amplifier, A.

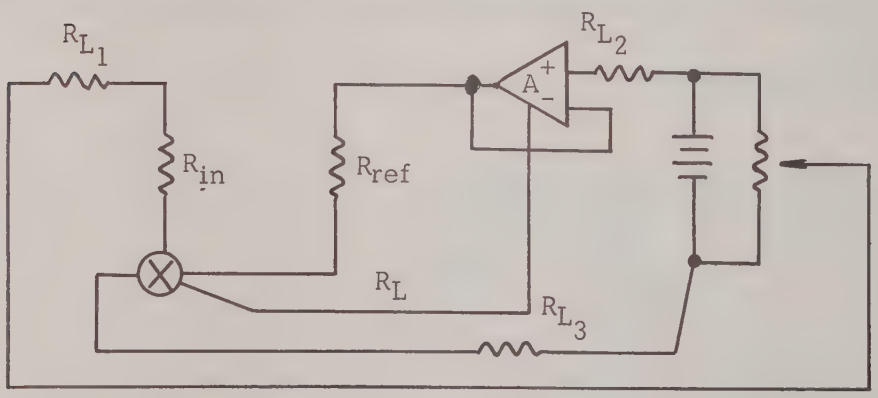


FIGURE 3.

Amplifier A presents a high resistance to the reference, thereby minimizing current flow in the reference return line R_L. Amplifier A can be designed with gain accuracies and linearity in the order of parts per million and a very high input resistance. The greatest error appears

as an offset current or current error. For a well-designed solid-state amplifier, this value can be kept to less than 100 nanoamps absolute and less than 1 nanoamp/°C. $E_{R_L} = 0.8\ (0.2) \times 10^{-6} = 0.16\ \mu$ volts.

With a buffer amplifier of this type, 100 volt reference voltages can be handled by placing a divider at the reference source scaling the reference to 10 volts(10:1 divider). However, if the divider is part of the ratiometer, the problems of low reference resistance as outlined before are present. Therefore, the preferable hookup is that shown in Figure 4, with a suitable divider consisting of $R_1 = 90$ k and $R_2 = 10$ k.

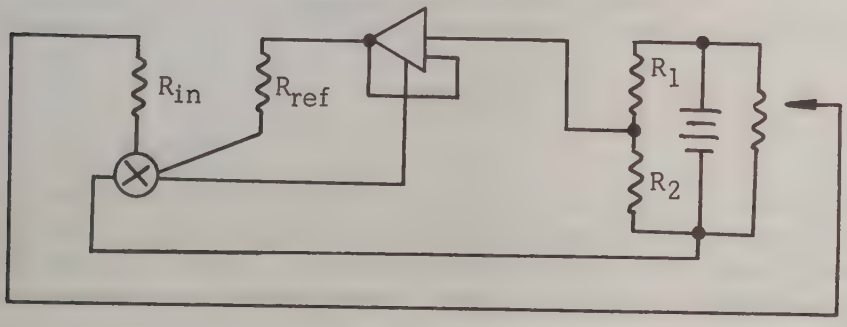


FIGURE 4.

The divider can be adjusted to compensate for the error due to the amplifier error current. Error = $R_2\ I_A$, where I_A = amplifier error current as function of temperature = 1×10^{-9}/°C.

Error = $1 \times 10^{-9}\ (10^{+4}) = 1 \times 10^{-5} = 10\ \mu$ volts/°C = 1 ppm/°C

Therefore, by providing a high input resistance and with the proper placement of dividers for high voltage operation, three-wire ratio operation is possible, even where lead lengths may be of considerable length.

An additional benefit of using a divider for the 100 volt reference is that an additional reference range is gained. With a 100 volt reference and 10 volt FS input, the full scale ratio range is 0.1. Ratios can be read to 1 ppm resolution with a five decade instrument.

Lead resistance problems become more severe when considering ac signal fources. Consider the circuit shown in Figure 5.

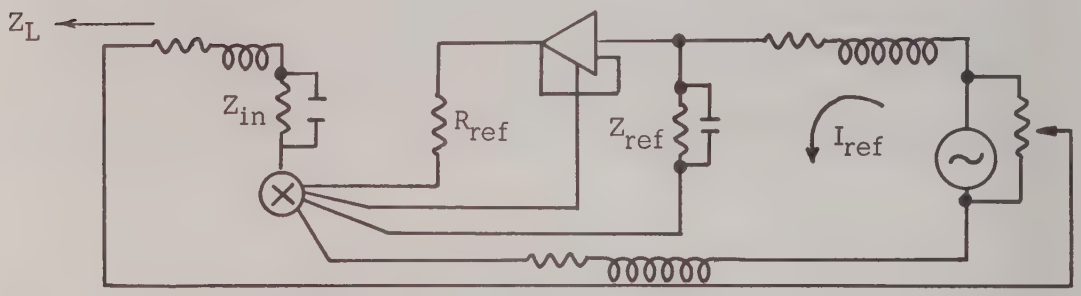


FIGURE 5.

For simplification, the leads are assumed to be resistive and inductive only. A more general analysis would require the consideration of distributed capacity and inductance of the lines, complications which are not considered in this discussion. Cable capacity is lumped at Z_{in} and Z_{ref}.

$L = 1\ \mu h/foot$

$R_L = 0.1$ ohm/foot

$R_{in} = R_{ref} = 10^6$ ohms

$C_{in} = C_{ref} = 47$ pf + 30 pf/foot

For an 8-foot cable:

$R_L = 800$ milliohms

$C_{in} - 300$ pf

$L = 8\ \mu h$

$$Z_{in} = Z_{ref} = \frac{R_{in}\frac{1}{f\omega L_{in}}}{R_{in} + \frac{1}{f\omega L_{in}}}$$

The two effects to be examined are the error in the reference voltage and offset voltages due to I_R.

At low frequencies, the analysis is similar to the dc case. $E_{ref} = 10$ volts.

$$I_{ref} = \frac{10 \text{ volts}}{10^{+6}} = 10^{-5} \text{ amps}$$

$$E_{offset} = 0.8 \text{ ppm of FS}$$

$$E_{ref\ error} = 16 \text{ ppm of reading}$$

As frequencies increase, the error is magnified. For example:

$$\omega = 3 \times 10^5 \text{ radians/sec}$$

$$X_L = (8 \times 10^{-6})\ (3 \times 10^5) = 2.4 \text{ ohms}$$

$$X_L = \frac{1}{0.9X_L^{-4}} \simeq 10^4$$

$$Z_{in} \simeq 1 = 4 \text{ ohms}$$

$$R_L + X_L = 3.2 \text{ ohms}$$

$$\% \text{ of FS error} = \frac{320}{10^4} = 0.03\% \text{ of full scale}$$

$$\% \text{ of reading} - 640 \times 10^{-4} = 0.064\% \text{ of reading.}$$

At full scale, the error is equal to 0.09%, since the effect is now additive. At 10% of FS, the percent of reading error is 0.6%.

For a given set of input cables, the percent of reading error can be compensated for by calibration of the reference ac converter. However, the percent of FS error cannot be compensated readily. Short leads are desirable where high frequency measurements are required.

FOUR-WIRE RATIOMETER

Consider the circuit shown in Figure 6. By the addition of an external differential amplifier, A_2, four-wire ratio measurements are possible. The system accuracy is dependent on the properties of A_2. Gain inaccuracies, linearity, common mode rejection and drift of A_2 will limit the ultimate accuracy. Amplifiers are available with gain and linearity accuracies of 0.01%, with less than 1 microvolt/°C drift and 120 db common mode rejection.

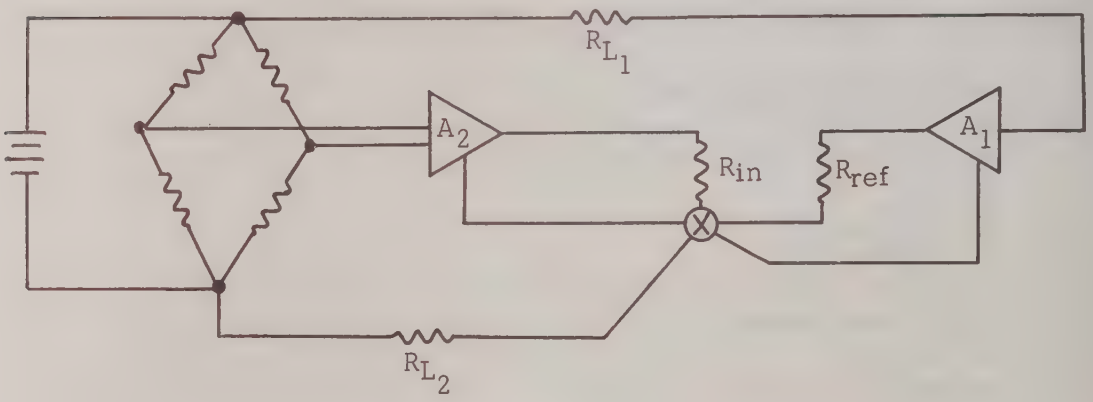


FIGURE 6.

Reference return current is less critical in this application, since drops in R_{L_2} appear only as common mode voltage to amplifier A_2. Drops in R_{L_1} and R_L which would affect the true reference voltage could be trimmed out by adjusting the gain of A_2.

By inserting an ac converter after A_2 and A_1 and substituting an ac generator for the battery shown, the bridge characteristics can be examined over a range of frequencies.

The ac excitation method has the further advantage that by using a low frequency where the reactance of the bridge is negligible, drift or thermal voltages in the test setup can be eliminated. For production testing where bridge characteristics only are desired, this can mean a saving time and better accuracy by eliminating the need for checking and setting zero.

LOW LEVEL RATIO MEASUREMENTS

In dc applications where the excitation voltage to the device becomes very small, the greatest source of error is zero drift. For example, consider Figure 7. The measurement is to determine the gain, A, of the amplifier. If the measurement is made at dc, assume the following parameters:

Ref = ±10 volts
Amplifier output maximum = ±10 volts
Amplifier gain = 1000
Divider is a 6-dial Kelvin Varley with 100 m linearity
Divider input resistance = 10,000 ohms

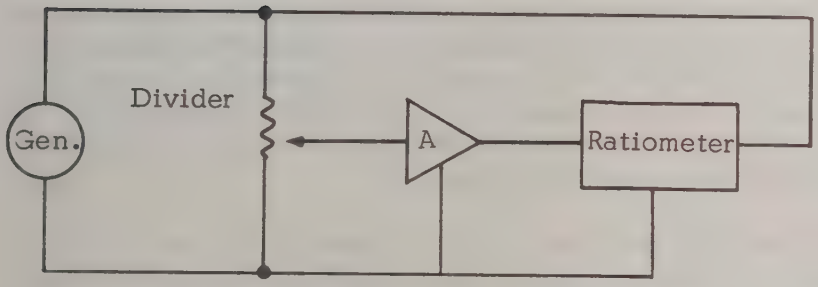


FIGURE 7.

The divider is set to $\frac{1}{A}$, when A is the nominal amplifier gain. Deviation can be read directly on the ratiometer. For example, if the gain is exactly 1000, the divider setting is 0.001, and the ratiometer reading is 1.0000. If the gain is in error by -0.05%, the reading is 0.9995. However, for a gain of 1000, the equivalent input voltage is 10/1000 = FS. To achieve a 0.01% measurement, the error input voltage must be less than $\frac{10 \times 10^{-3}}{10^{+4}} = 1\ \mu$ volt

To maintain a less than 1 μ volt dc error requires careful selection of the test setup, leads and zero adjustment. If the zero should shift during the measurement, an apparent error in gain will be observed. With care, 2-3 μ volts might be obtainable in a production test, which would give a 0.02-0.03% of FS error. The divider accuracy was given as 1 ppm, or at a setting of 0.001 is equal to 0.1%.

The best obtainable accuracy of the dc system is 0.1% of reading +0.03% of FS.

Also, a two-step test should be performed with plus and minus signals to test the amplifier output for both polarities.

For a good wideband dc amplifier, the gain accuracy should be flat to 100 cycles or more. If the dc excitation is replaced with an ac source and the dc divider is replaced with a good ratio-transformer, the following advantages are gained:

The zero-drift term is eliminated. The amplifier output is tested in both polarities simultaneously, and the accuracy of the ratio-transformer is greater than that obtainable with a dc divider. A seven-dial ratio transformer is capable of accuracies of 0.1 to 0.5 ppm. The ratio-transformer also presents a lower and more constant output impedance than is possible with the resistive divider.

The accuracy obtainable, therefore, is in the order of 0.01 to 0.05% of reading. A greater benefit is the elimination of checking and setting zero, and the need for a reversal test. Measurements on dc amplifiers can be made with greater accuracy and speed. When low level dc measurements are to be made, the possibility of using an ac source should, therefore, be examined.

When the measurement involves ratios greater than 10 or less than 0.1, the use of external dividers can enhance the performance.

The principles involved in the example can be extended to many measurement problems, involving transducers, as well as amplifiers, networks, and components.

APPENDIX B

REFERENCES

Following is a list of publications available to the Digital Voltmeter, Dana Model 5600-S-638, operator and maintenance personnel.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins and Lubrication Orders.
DA Pam 310-7	U. S. Army Equipment Index of Modification Work Orders.
TM 38-750	The Army Maintenance Management System (TAMMS).
SB 38-100	Preservation, Packaging, Packing, and Marking Materials, Supplies, and Equipment used by the Army.
TB 746-10	Field Instruction for Painting and Preserving Electronic Equipment.
TB 750-236	Calibration Requirements for the Maintenance of Army Materiel.

APPENDIX C

BASIC ISSUE ITEMS LIST AND

ITEMS TROOP INSTALLED OR AUTHORIZED LIST

Section I
Introduction
C-1 SCOPE
C-1.1 This appendix lists items which accompany the digital voltmeter 5600-S-638 or are required for installation, operation, or maintenance.
C-2 GENERAL
C-2.1 This Basic Issue Items List and Items Troop Installed or Authorized List is divided into the following sections:

(*a*) Basic Issue Items – Section II. A list of items which accompany digital voltmeter 5600-S-638 and are required by the operator crew for installation, operation, or maintenance.

(*b*) Items Troop Installed or Authorized List – Section III. Not applicable.

Section II
BASIC ISSUE ITEMS LIST

Description	*Mfr Part No*
Power Line Cable	600127
Signal Input Cable Assembly	400396
Reference Input Cable Assembly	400397
Calibration Cable	400328
Rack Mounting Flanges and Screws	450362

APPENDIX D

MAINTENANCE ALLOCATION CHART

MAINTENANCE ALLOCATION CHART Date: 23 March 1972

Nomenclature of End Item or Component:

DIGITAL VOLTMETER 7912073

This Maintenance Allocation Chart designates overall responsibility for the performance of maintenance functions on the identified end item or component. The implementation of field maintenance tasks upon this end item or component will be consistent with the assigned maintenance operations which are defined as follows:

Operation	Definition
Depot	That level of logistics which has the facilities, personnel and capabilities to equal the quality of the equipment repair available at the contractor's facilities. (D)
Reference	That level in the maintenance of calibration equipment which provides DS and GS logistical support. (H)
Transfer	That level in the maintenance of calibration equipment which provides organizational and limited DS logistical support to Secondary Transfer equipment. (F)

MAINTENANCE ALLOCATION CHART

FOR VOLTMETER/DIGITAL 5600-S-638

CHART NUMBER 7912073

MAC PAGE

GROUP NUMBER	FUNCTIONAL GROUP	MAINTENANCE FUNCTIONS												
		a	b	c	d	e	f	g	h	i	j	k	l	m
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	TOOL REQD.	REMARKS
1	VOLTMETER/DIGITAL	F	F	F	-	-	F	F	F	F	D	-	ALL	A
2	PRINTER DRIVER	F	-	-	-	-	-	-	F	F	D	-		
3	FUNCTION READOUT	F	-	-	-	-	-	-	F	D	D	-		B
4	DIGITAL READOUT	F	-	-	-	-	-	-	F	D	D	-		B
5	AUTO RANGE	F	-	-	-	-	-	-	F	D	D	-		B
6	PROGRAM	F	-	-	-	-	-	-	F	D	D	-		B
7	LOWER ORDER DECADE	F	-	-	-	-	-	-	F	D	D	-		B
8	1,000 DECADE	F	-	-	-	-	-	-	F	D	D	-		B
9	10,000 DECADE	F	-	-	-	-	-	-	F	D	D	-		B
10	NULL DETECTOR	F	-	-	-	-	-	-	F	D	D	-		B
11	INTERNAL REFERENCE & BUFFER AMPLIFIER	F	-	-	-	-	-	-	F	D	D	-		B
~~12~~	~~FILTER~~	F	-	-	-	-	-	-	F	F	D	-		
13	AC/DC CONVERTER	F	-	-	-	-	-	-	F	D	D	-		B
14	PREAMPLIFIER	F	-	-	-	-	-	-	F	D	D	-		B

MAINTENANCE ALLOCATION CHART

FOR VOLTMETER/DIGITAL 5600-S-638

CHART NUMBER 7912073

TOOLS REQUIRED PAGE

TOOL CODE	CATEGORY	NOMENCLATURE	TOOL NUMBER
1b, 1f, 1i	F	AC VOLTAGE STD, H-P 745A-C90	MIS-10342
	F	AUTOTRANSFORMER, GR W10MT3AS3	7910809
	F	DC VOLTAGE STD, JF 332A	7911393
	F	GALVANOMETER, ESI 801	7912151-2
	F	NULL DETECTOR/DC VOLTMETER, JF887 A BAN	MIS-10216
	H	RESISTANCE BRIDGE, ESI SP 2980	MIS-10281
	F	RESISTANCE BRIDGE, ESI 230B	7912150-2
	H	RESISTANCE STD, BIDDLE GRAY 601147-1	7910328
	F	RESISTANCE STD, GENERAL RESISTANCE RDS615B	MIS-10264
	F	STD CELL, JF 730 A	MIS-10358
	H	VOLTAGE DIVIDER, ESI RV 726	MIS-10295
	F	VOLTAGE DIVIDER, GENERAL RESISTANCE DV 4107 C	MIS-10274
	H	AC-DC THERMAL VOLTMETER, HOLT 10	7911000-1
	F	THERMAL XFER STD, JF 540 B	MIS-10217
	F	AC POWER SUPPLY, N-H SF 613	MIS-10222A
	F	ADAPTER (2 EA)	7907556
	F	CALIBRATION KIT	7913341
	F	LEAD (2 EA)	790797
	F	LEAD (5 EA)	7907498
	F	TOOL KIT	7659911

MAINTENANCE ALLOCATION CHART

FOR VOLTMETER/DIGITAL 5600-S-638

CHART NUMBER 7912073

REMARKS PAGE

REMARKS CODE	REMARKS
A	TEST IN ACCORDANCE WITH CALIBRATION PROCEDURE TB 9-6625-1293-50.
B	BOARDS UNDER EXCHANGE PROGRAM.

By Order of the Secretary of the Army:

W. C. WESTMORELAND
General, United States Army
Chief of Staff

Official:
VERNE L. BOWERS
Major General, United States Army
The Adjutant General

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STS CULVER CITY CA 90230

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